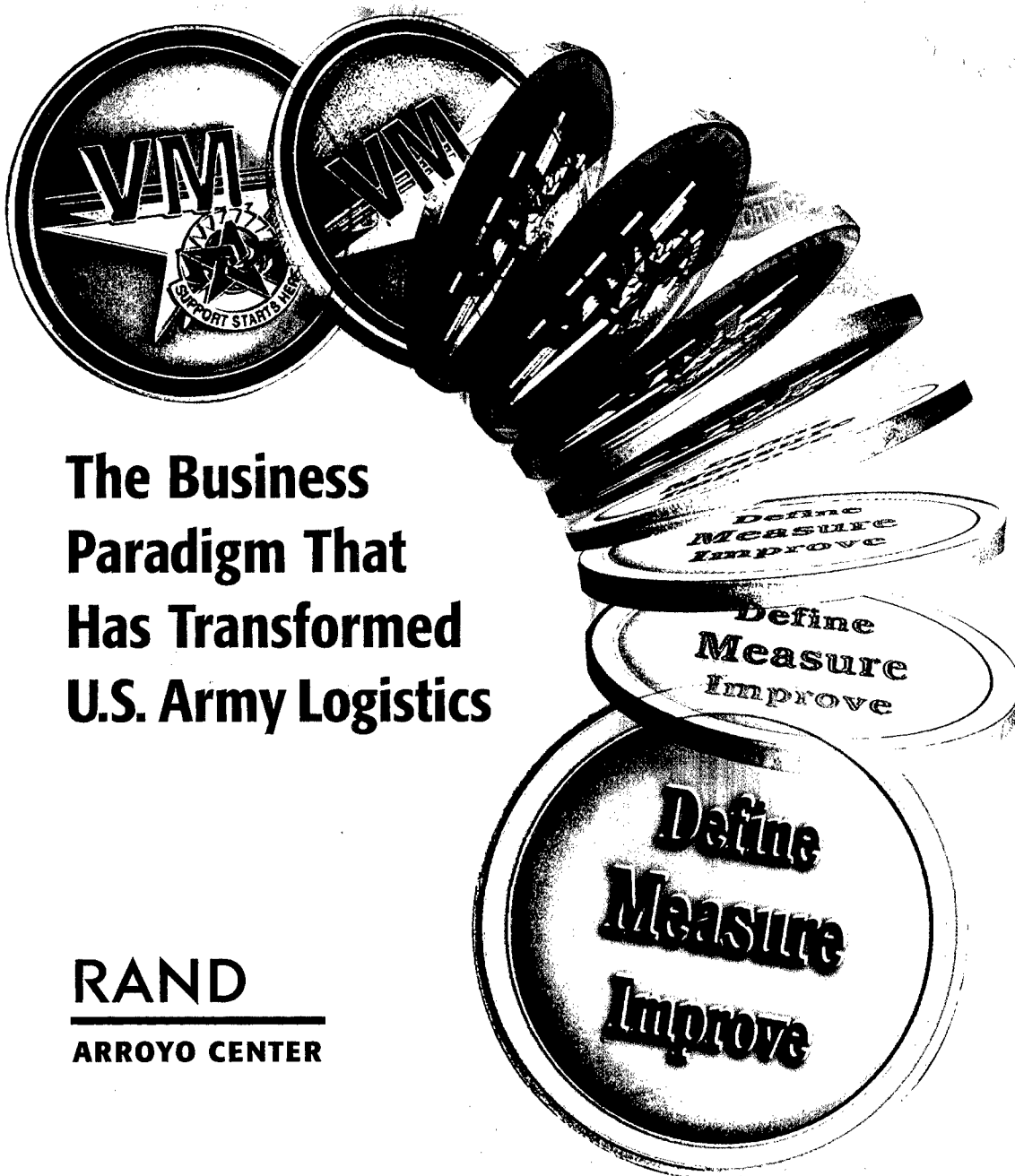


VELOCITY MANAGEMENT



**The Business
Paradigm That
Has Transformed
U.S. Army Logistics**

RAND

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**The Business Paradigm That
Has Transformed
U.S. Army Logistics**

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Approved for public release; distribution unlimited

20011010 096

The research described in this report was sponsored by the United States Army under Contract No. DASW01-01-C-0003.

Library of Congress Cataloging-in-Publication Data

Velocity management : the business paradigm that has transformed U.S. Army logistics / John Dumond ... [et al.].

p. cm.

Includes bibliographical references.

"MR-1108."

ISBN 0-8330-2773-5

1. United States. Army—Procurement. 2. United States. Army—Supplies and stores. 3. United States. Army—Management. 4. Logistics—Management. I. Dumond, John, 1945–

UC263 .V45 2001

355.6'212'0973—dc21

2001031903

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Published 2001 by RAND

1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138

1200 South Hayes Street, Arlington, VA 22202-5050

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Preface

At the outset of the 1990s, customers of the U.S. Army's logistics system could justifiably complain about many aspects of its performance. The system was huge, moving massive amounts of materials and supplies and employing thousands of Army personnel and outside contractors. It was also unreliable, inefficient, unresponsive to changing customer needs, and expensive. These problems persisted despite repeated efforts to remedy them. For this reason, successfully reforming the Army's logistics system—much less achieving the “transformation” that many called for—required a fundamental shift in approach to how the Army thought about logistics and how it thought about change.

In 1995, the Army's Velocity Management (VM) initiative brought a new way of doing business to U.S. Army logistics. As the term “Velocity Management” implies, this initiative has focused on improving the speed and accuracy with which materials and information flow from providers to users. Through improved velocity and accuracy, it reduces the need for massive stockpiles of logistics resources.

Since 1995, the VM initiative has succeeded beyond all expectation. Key Army logistics processes have improved dramatically on the three dimensions of performance: time, quality, and cost. Today a high-velocity, streamlined order fulfillment process delivers repair parts in half the time it took to deliver them just three years earlier. The repair process is faster in turn, and improved inventory management means that customers can have ready access to a broader array of items. The accompanying financial system is also less cumbersome. The Army has propagated these improvements throughout its facilities and installations, both within the United States and abroad.

One key to the success of the VM initiative is the continued involvement of a determined coalition of senior Army leaders. Another is the adoption of a powerful process improvement methodology called D-M-I: Define-Measure-Improve. To implement VM, teams of experts define, measure, and improve logistics processes continuously. As a result of their efforts, the customers

● Velocity Management brought a new way of doing business to Army logistics.



of the logistics system—Army units in garrison and deployed worldwide—get what they need, when they need it, at affordable expense.

This report tells the story of VM's ongoing success: the motivations, methodology, and management structure behind the initiative; the process changes that led to rapid and continuous improvement; and the steps that were taken to develop and institutionalize the capabilities for achieving and sustaining process improvement. The contents of this report have been briefed widely among the senior leadership of the Army and of the Department of Defense more broadly. It will be of interest to any organization, public or private, seeking dramatic performance improvement.

The Velocity Management approach to process improvement was developed through research sponsored by the U.S. Army Deputy Chief of Staff for Logistics. U.S. Army Combined Arms Support Command (CASCOM) serves as the Executive Agent for the implementation; for information on the VM initiative, access <http://www.cascom.lee.army.mil/vm/>. RAND Arroyo Center researchers in the Military Logistics Program have provided analytic support and technical assistance to the Army's implementation efforts while continuing to extend the VM concept. RAND has also conducted research to adapt the Velocity Management concept to help improve the logistics system of the U.S. Marine Corps, in support of its logistics reforms (see Robbins et al., 1998, and Fricker and Robbins, 2000). RAND is conducting related studies in support of the Strategic Distribution Management Initiative for the Defense Logistics Agency and the U.S. Transportation Command.

The Arroyo Center is a federally funded research and development center that is sponsored by the U.S. Army.

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Summary

Since 1995, the Army's Velocity Management (VM) initiative has brought a new way of doing business to U.S. Army logistics. As the term "Velocity Management" implies, this initiative focuses on improving the speed and accuracy with which materials and information flow from providers to users. As a result of the VM initiative, key Army logistics processes have improved dramatically in terms of time, quality, and cost.

Velocity Management was developed as an alternative to the Army's traditional mass-based approach to logistics, under which vast quantities of supplies—spare parts, fuel tanks, extra vehicles, ammunition, and so forth—are kept on hand "just in case" they are needed. This approach was limited in responsiveness, reliability, and efficiency. The existence of massive stockpiles of supplies does not ensure that combat forces will get what they need when they need it, and mass requires a great deal of manpower and resources to manage and control. Moreover, mass-based logistics poses a tremendous cost to the warfighter in terms of footprint, risk, and mobility.

Replacing Mass with Velocity

Velocity Management replaces the Army's traditional reliance on mass with the modern business concept of high-velocity processes tailored to meet evolving customer needs. VM views the logistics system as a set of interlinked processes—a supply chain—that delivers products and services (such as spare parts and equipment maintenance) to customers. System performance is assessed in terms of the agility and responsiveness of logistics processes. Under VM, these processes are becoming faster, better, and cheaper.

To implement the VM system, the Army has institutionalized an improvement method consisting of three steps: **D**efine the process, **M**easure the process, and **I**mprove the process.

- The first step, "Define," identifies the customers of a process and specifies what they need from the process in terms of outputs. Inputs to the process are also defined, and the process itself is broken down into segments or subprocesses.





To increase understanding of a process, experts from all of its segments pool their collective knowledge and walk through its steps.

- Whereas the Define step aims to improve knowledge about how a process is done, the second step, "Measure," aims to improve knowledge about how well it is done. Improvement is sought on three dimensions of performance: time, quality, and cost. To support measurement in these areas, metrics are developed to reflect what the customers of the process need and value. These measures can be used to identify performance problems, monitor the effects of changes made to address these problems, and provide feedback to those implementing the changes.
- The third step, "Improve," capitalizes on the increased expertise developed during the first two steps. Armed with a deeper understanding of the process and of customer needs, along with improved capabilities to measure performance, process experts articulate realistic but challenging goals for improvement.

As performance improves, the D-M-I cycle begins again, with a remapping of the changed process, continued measurement, and additional process changes.

Because of the complexity of Army logistics processes and the many diverse stakeholders, the Army recognized the need for high-level commitment and a strong organizational structure to insure the success of the Velocity Management initiative. The initiative is guided and sustained by a coalition of senior leaders called the Velocity Management Board of Directors (or simply the Velocity Group [VGI]), led by three senior Army general officers: the Army's Deputy Chief of Staff for Logistics, the Deputy Commanding General of Army Materiel Command, and the Commanding General of Combined Arms Support Command.

VM is implemented by two types of teams. Armywide Process Improvement Teams (PITs) are composed of technical experts representing all segments of a process, as well as RAND analysts. PITs are charged with establishing detailed definitions of



their respective processes, developing processwide metrics and performance reports, analyzing current performance, and recommending process changes. Site Improvement Teams (SITs) are installation-level teams composed of local technical experts and managers. These teams apply the D-M-I method to local processes and serve as a mechanism for implementing improvements Army-wide.

As the Army has implemented VM, it has moved toward new metrics to focus on process capabilities rather than on piles of mass. In particular, the Army, and now the Department of Defense, measure “customer wait time” (CWT). CWT captures the time from when a customer orders an item until the order is filled. CWT provides an aggregate measure of the performance of a variety of logistics processes. It will vary according to what is stocked locally; what is stocked at other locations; how long it takes either to repair or to procure items that are not in stock; how long it takes to process and ship material; how long it takes to receive and process shipments; and so on. As a result, CWT is a high-level metric that can be used to drive improvements in processes throughout the logistics system.

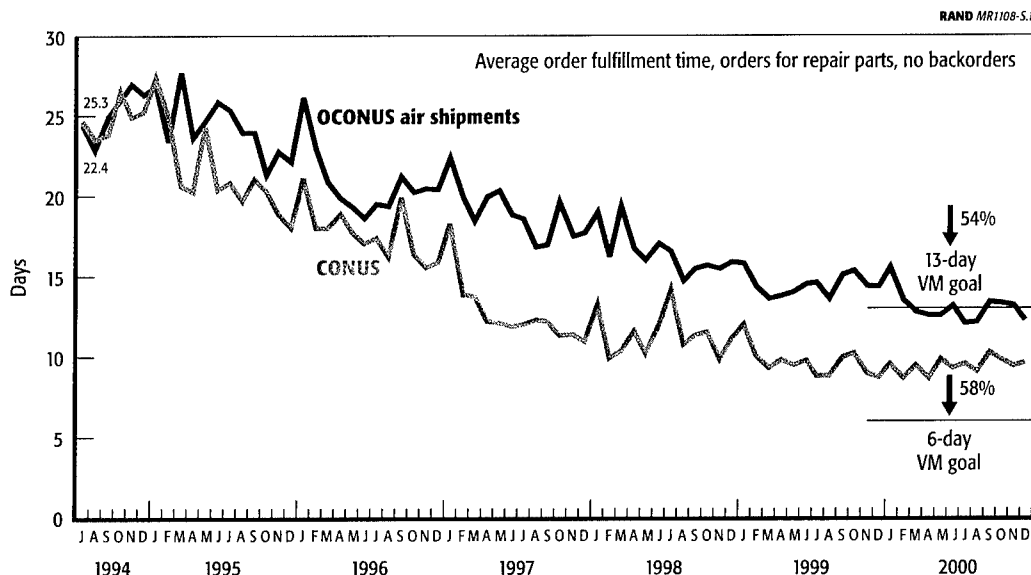
Improving the Order Fulfillment Process

Implementation of the Army’s Velocity Management initiative has resulted in dramatic improvements in logistics processes. The starting point for improvement was the order fulfillment process. Quick and reliable delivery of spare parts for weapon system repair is critical to sustaining equipment readiness, but both the speed and reliability of this process needed improvement. Before VM, average CWTs were very long, and the process was also highly variable, with some requisitions taking weeks or even months to fill. The VM teams initially focused on improving the time dimension of the order fulfillment process for orders received through the Army’s wholesale supply sources. As part of the Define step, VM teams walked through each step of the process at a major Army installation. RAND analysts then used existing Army data to establish a baseline for tracking improvements in the performance of order fulfillment. To facilitate these measurements, the CWT PIT

● Customer wait time is a high-level metric that can be used to drive improvements in processes throughout the logistics system.

The implementation of Velocity Management resulted in improvements throughout the order fulfillment process. Some quick fixes were achieved at the local level with no added costs. For example, Army installations strengthened oversight, simplified rules, improved the performance of new requisitioning and receipting technologies, reduced review processes, and streamlined on-post deliveries. Other changes involved coordination among multiple organizations within and outside the Army. The introduction of regularly scheduled trucks reduced delays and variability in shipping times. Installations further streamlined the process through the use of automated sorting and receipting systems. The repositioning of stock at some depots allowed orders to be processed more efficiently, while many installations also redesigned their delivery routes, work schedules, and distribution

Figure S.1 Through the VM initiative, order fulfillment times have improved dramatically and continuously



CONUS = repair parts requisitions originating in CONUS except for National Guard and U.S. Army Reserves.

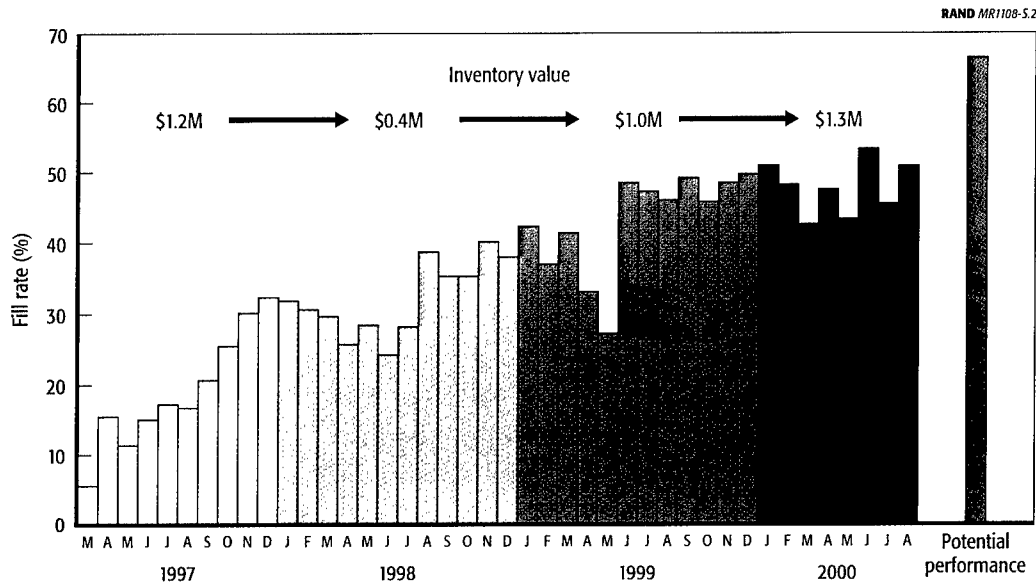


systems. These changes resulted in a much faster, more reliable order fulfillment process. Figure S.1 displays the dramatic reductions in customer wait times for major installations of U.S. Forces Command both inside and outside the continental United States (CONUS and OCONUS). Importantly, improvements have not been confined to a limited set of customers: the Army has been able to replicate the successful reduction of CWT for all units. Moreover, CWT performance has also improved for Army units stationed and deployed abroad.

Improving the Inventory Management Process

Success builds on success. The Velocity Management methodology has also been applied to the Army's inventory management, repair cycle, and financial management processes. The inventory management process determines which items and how many of each to stock at an installation's local supply warehouses. Stockage decisions require a tradeoff between customer performance objectives and cost and mobility requirements. Members of the Stockage Determination PIT began their work by visiting installations to define the inventory management process. This initial step identified opportunities for quick improvements in warehouse storage and workflow such as stock repositioning and improved receipting processes. Two sets of inventory management metrics were then developed: performance metrics and resource metrics. Performance metrics focus on the time and quality dimensions, while resource metrics measure costs.

Under Velocity Management, both dimensions of performance have improved. RAND analysts developed new algorithms for determining stockage levels, which improved both the breadth and depth of inventory, allowing more low-cost, high-demand items to be stocked. These changes produced immediate and dramatic improvements in inventory performance, as shown in Figure S.2, which tracks the percentage of orders filled from stocks on hand (fill rate) at one local supply warehouse. After the implementation of VM, the fill rate here rose from about 5 percent to about 50 percent. This improved performance was achieved without a large additional investment. Before the implementation of



Computed from document histories at one SSA.

● **Figure S.2** Broader, shallower stocks can yield better fill rates for the same investment

the new algorithms, this supply warehouse had approximately \$1.2 million in inventory. During the multiphase improvement effort, unneeded items were returned to inventory, and some of the credit was used to add lines to broaden inventory and improve performance. As funds became available, the breadth of inventory was expanded, and the investment level rose to \$1.3 million.

Improving Repair Times

Improved CWTs and improved responsiveness from local stocks helped Army mechanics receive the parts they needed sooner, which contributed to reduced repair times. VM also created additional opportunities for improvements in repair cycle times. The Define step of the VM methodology was critical in this regard. The Repair PIT stipulated a definition of the repair cycle that extends from the time an item is broken until it is fixed—as opposed to the Army's traditional definition, which was limited to hands-on repair time in the shop. The new definition allowed for a more complete understanding of the repair process, making it easier to identify non-value-added activities that could be eliminated. Many opportunities for improvement were identified during initial walk-throughs of the repair process. Several of these changes could be implemented immediately, including procedural changes to reduce administrative workload and the elimination of repetitive inspec-

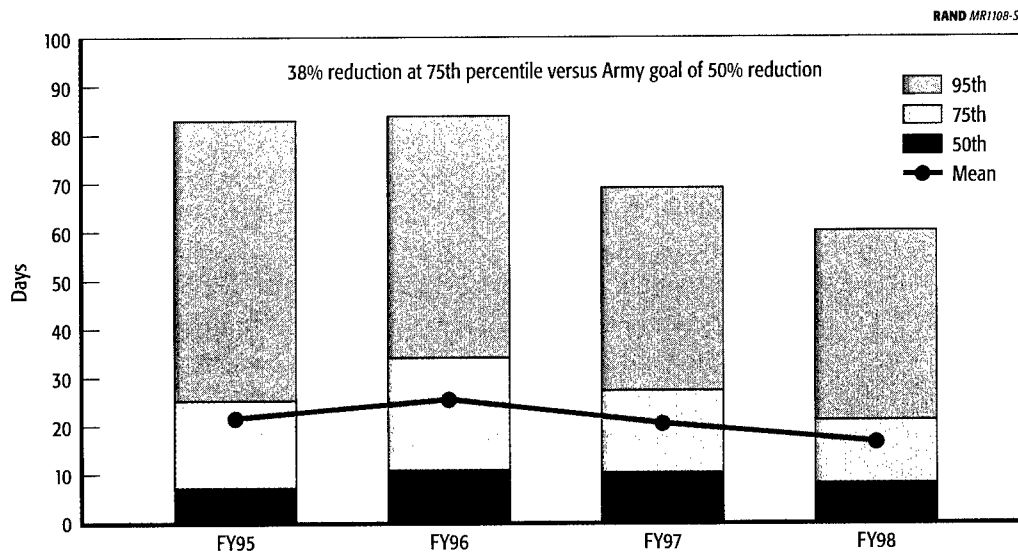
tions and unnecessary cleaning procedures to save maintenance manpower and reduce time.

The VM efforts to improve the repair process have had significant benefits. Figure S.3 shows four years of repair cycle time (RCT) performance, the baseline period and three subsequent years. During that period, this installation achieved a 38 percent reduction in RCT at the 75th percentile, compared to the goal of 50 percent set in 1996 by the Army's Vice Chief of Staff. The improvements are particularly remarkable at the 95th percentile, indicating that the process became much more reliable in its performance. Moreover, these improvements were achieved without added expense.

Improving the Quality of Financial Information

The VM methodology was also applied to the financial management process. Logisticians depend on the Army's financial management process for timely, reliable, and accurate data about item prices, credits issued, and other financial issues. Price and

● **Figure S.3** Repair cycle time for Fort Campbell ground units shows significant improvement



SOURCE: WOLF data for 510 part numbers tracked by RCT PIT.



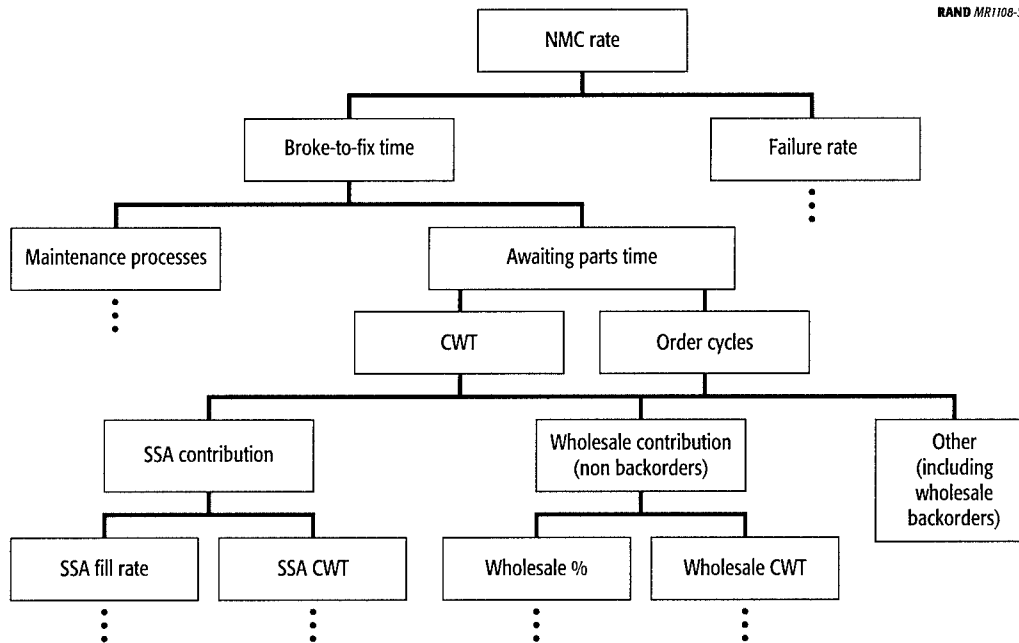
credit information is of particular concern because so many logistics decisions depend on the knowledge of how much money a unit has to spend at a given time. Walkthroughs of the financial management process indicated that improvements were needed in both the timeliness and the quality of critical financial information. The Financial Management PIT sought improvements in several areas: reducing uncertainties in prices and credits, reducing the time required to provide information such as catalogs and budget updates, and improving access to information. Needed improvements may require investments in key areas such as automated systems, expanded networks, and additional staff. Many of these changes require policy changes at the Headquarters Department of the Army or the Office of the Secretary of Defense. A continued commitment from Army leadership is required to secure cooperation both within and outside the Army to implement change.

Linking Process Improvement to Increased Readiness

As VM was achieving its goals of making Army logistics processes faster, better, and cheaper, the next step was to assess the effect of these improvements on equipment readiness. For this purpose, RAND developed the Equipment Downtime Analyzer (EDA), which is a relational database that saves, integrates, and analyzes data collected by existing standard Army management information systems (STAMIS). This data tracks the daily history of the supply and maintenance activities executed to correct every reported failure that causes a piece of equipment to be unavailable ("not mission capable," or NMC). The EDA thus provides a systems view that can determine how much each process and organization contributes to equipment downtime. From the daily history, the EDA creates a hierarchy of linked metrics that fully describe equipment failure rates and the "broke-to-fix" process (see Figure S.4).

The EDA can be used to identify the underlying causes contributing to repair times or failure rates. It can highlight the places where improvements would make the most difference in equipment readiness. It can also measure the frequency with which workarounds occur (e.g., when a repair is made by removing a needed part from another piece of equipment) and can iden-

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● **Figure S.4** The EDA uses data from Army management information systems to create a hierarchy of linked metrics

tify multiple ordering cycles (e.g., because of changed diagnoses). The EDA can distinguish the performance of different maintenance units and of different levels of maintenance in the Army. Army organizations have already identified several additional ways to exploit the more precise and complete insight that the EDA data allow. It can be used to help evaluate and improve design reliability, to make recapitalization decisions, to identify operating shortfalls, and to enhance supply and maintenance policy analysis. The ultimate promise of the EDA is an enhanced capability to focus constrained resources where they will have the greatest effect on keeping equipment ready to fight, whether by improving equipment reliability or by reducing repair times.

Sustaining Continuous Improvement

The Velocity Management initiative has provided the Army with a new way of thinking about and organizing logistics processes to be more efficient and effective. The Army is using a number of mechanisms to sustain the VM initiative so that it is not limited to the duration of a single budget cycle or general officer's tenure:

- VM has been implemented with the participation of Army leaders of sufficient scope and authority to make



● [The Army] has unexpectedly demonstrated a remarkable capability for achieving quick, dramatic, and lasting change.

systemwide change. The Army's formation of the Velocity Group also helped solved the problem of how to sustain an initiative that by its nature must outlast the tenure of any given general officer, and even any cohort of officers.

- Another key to sustaining the VM initiative has been the institutionalization of the Define-Measure-Improve method. Of particular importance is the Measure step, which entails the development and implementation of metrics such as CWT that span the full process and reflect key customer values. These metrics become the lingua franca by which all the stakeholders in a process communicate with one another about the goals and status of their improvement efforts.
- The quick pace of implementation has also helped to sustain the VM initiative, particularly by emphasizing that the improvement of process performance is a continuous goal, not a one-time transition to a new target state.
- Another key to sustaining the initiative has been its systematic application to new processes and sites. These extensions continually renew interest in the initiative.
- Finally, a large part of VM's sustained success is due to the fact that the initiative has achieved significant improvements in performance within the constraint of existing (and sometimes declining) resources.

Under the Velocity Management paradigm, the Army continues to transform its logistics system into a strategic asset that can support new concepts for deploying and fighting. And in doing so, the institution has unexpectedly demonstrated a remarkable capability for achieving quick, dramatic, and lasting change.

Acknowledgments

This document records the achievements of a wide-ranging effort and reflects the hard work of individuals from many organizations who contributed to the implementation of Velocity Management across the U.S. Army.

We begin by gratefully acknowledging our debt to the Army logistics leadership. These individuals include GEN Johnnie E. Wilson (U.S. Army, ret.), GEN John G. Coburn, LTG Daniel G. Brown, LTG Henry T. Glisson, LTG Charles S. Mahan, Jr., LTG John M. McDuffie, LTG Billy K. Solomon, MG Charles C. Cannon, Jr., MG Dennis K. Jackson, MG Kenneth L. Privratsky, MG Julian A. Sullivan, Jr., BG Barbara Doornick, BG Phillip M. Mattox, Mr. Robert Keltz, Mr. Wimpy D. Pybus, and Ms. Donna Shands.

The dedication records a special debt to two general officers, MG Thomas W. Robison (U.S. Army, ret.) and MG James M. Wright (U.S. Army, ret.), who passed away before they witnessed the full fruits of their early advocacy of the Velocity Management initiative.

We acknowledge a particular debt to the contributions of several Army personnel who were critical to getting the VM implementation off the ground: COL Glenn Harrold, MAJ Rich O'Connor, CW4 Ray (Ramon) Navarro (U.S. Army, ret.), and Dr. Dan Parker (U.S. Army CW4, ret.).

This document also reflects the contributions of numerous current and past members of the four Process Improvement Teams (PITs). We especially thank the leaders of these four teams, the so-called PIT Bosses: Thomas J. Edwards, Deputy to the Commanding General, CASCOM, leader of the Customer Wait Time PIT; MG Mitchell H. Stevenson, leader of the Repair Cycle PIT; MG Hawthorne "Peet" L. Proctor, leader of the Stockage Determination PIT; and Mr. Ernest J. Gregory, leader of the Financial Management PIT.

We also wish to acknowledge the research contributions of our RAND colleagues, past and present, including Jack Abell, Darlene Blake, John Bondanella, Pat Boren, Steve Brady, James Crowley, Dave Diener, Ron Fricker, Earl Gardner, John Halliday,





Dave Kassing, Art Lackey, Matthew Lewis, William Lewis, Doug McIver, Lou Miller, Dave Oaks, William O'Malley, Jim Quinlivan, Dan Relles, Marc Robbins, Michael Shanley, Jerry Sollinger, Richard Stanton, Paul Steinberg, Mark Totten, and Mel Wolff. LTG Vincent Russo (U.S. Army, ret.) and Professor Vincent Mabert (Indiana University), RAND consultants, regularly provided expert and insightful perspectives on our research. General Russo and Tom McNaugher, Deputy Director of the Arroyo Center, provided technical reviews of this report that stimulated a thorough revision. Nikki Shacklett, a RAND editor, improved the report in many ways. Kristin Leuschner, a RAND communications analyst, drafted the summary. Barbara Angell created the book design. Finally, we thank photographer Diane Baldwin and graphic designers Pete Soriano and Maritta Tapanainen for their contributions to the cover design.

Glossary

ASLP	Army Strategic Logistics Plan
ASP	Ammunition Supply Point
CASCOM	Combined Arms Support Command
CONUS	Continental United States
CWT	Customer Wait Time
DLA	Defense Logistics Agency
D-M-I	Define, Measure, Improve
DOS	Days of Supply
DVD	Direct Vendor Delivery
EDA	Equipment Downtime Analyzer
FADE	Focus-Develop-Analyze-Execute
FMC	Fully Mission Capable
GCSS-A	Global Combat Support System–Army
GSA	General Services Administration
LIF	Logistics Intelligence File
LRT	Logistics Response Time
NMC	Not Mission Capable
OCONUS	Outside the Continental United States
OST	Order and Ship Time
PDCA	Plan-Do-Check-Act
PIT	Process Improvement Team
RCT	Repair Cycle Time
RO	Requirements Objective
SIT	Site Improvement Team
SSA	Supply Support Activity
STAMIS	Standard Army Management Information Systems
TACOM	Tank-Automotive and Armaments Command
VCSA	Vice Chief of Staff, Army
VG	Velocity Group
VM	Velocity Management
WIP	Work-in-Process Inventory

To the memory of

MG Thomas W. Robison
(U.S. Army, ret.)
1939–1998

and

MG James M. Wright
(U.S. Army, ret.)
1944–2000

1 A Paradigm for Dramatically Improved Performance

The Mass-Based Approach to Logistics

If people think of Army logistics at all, they probably think of mountains of metal—for example, the massive stocks of spare parts, fuel tanks, extra vehicles, and ammunition that stacked up in Saudi Arabia as the Army prepared to go to war in 1991. There the Army employed a mass-based approach to supporting combat forces.¹ During the first three months of the Gulf War, more than one million tons of supplies and equipment were shipped into theater. Another 175,000 tons were airlifted in.²

Under a mass-based approach to logistics, support is commonly measured in terms of “days of supply.” For example, to support the two corps executing the famous flanking maneuver during the Gulf War, the Army brought forward enough food and water to sustain the troops for 29 days, adequate fuel to move for 5.2 days, and enough ammunition for 45 days. Each day of supply for ammunition was expected to be 14,000 tons. Each day of fuel approached 4.5 million gallons. Under mass-based logistics, the more days of supply, the better. During the 100 hours of ground combat of the Gulf War, even more supplies and provisions were moved forward, so that there were then 65 days of ammunition supply (Pagonis, 1992, p. 147).

Why Mass?

Moving mountains of support is intended to hedge against the uncertainties of war. There are uncertainties about demand—what will be needed to accomplish the mission?—and these are complicated by uncertainty about what the enemy will do. It is incredibly hard for the Army to anticipate all the trends in demand for supplies and services when it faces a thinking enemy and has an immense variety of equipment to support.

1 The mass-based approach to logistics is described well by Lieutenant General William Pagonis (U.S. Army, ret.) in his book *Moving Mountains* (1992).

2 The United States has moved similar mountains of material for every major engagement in modern history. In the first 90 days following the attack on Pearl Harbor we moved 836,000 tons. In the first 90 days in the Korean conflict we moved 980,000 tons, and in the first 90 days of Vietnam we moved 1.3 million tons.



There are also uncertainties of supply to contend with: how quickly and reliably can these needs be satisfied? Given very long lead times, the only hope of getting something in a reasonable timeframe is to stockpile lots of it. To get enough of everything requires mountains of supplies. Customers of the logistics system quickly learn to compensate for slow and unreliable performance. They realize that if what they need is not there, it may be very tough to get it. Therefore, they ask for even more mass to protect themselves.

It is important to recognize that the military case differs crucially from its commercial analogs. Consider the situation of a clothing retailer who also faces uncertain demand and long lead times. If the retailer's suppliers have a nine-month lead time, then he must order everything for the spring line in the previous summer. Not wanting to lose sales, he tries to anticipate everything that might be ordered. When spring arrives, he invariably discovers that the forecast is not quite right. Unneeded items will have to be marked down or written off. With the long lead times, there will be no way to respond to unanticipated fashion trends, resulting in lost sales opportunities. Still, the retailer recognizes the high cost of ordering too much: this cost directly affects his bottom line, and because of this risk to profit, he limits the initial order to a carefully constructed forecast. For the retailer, ordering too much is just as or even more costly than ordering not enough.

For the Army, however, not ordering enough could entail tremendous risk. The cost of a deployed Army unit not having what it needs to fight, survive, and win is considered much worse than the cost of having unneeded things around when the conflict ends. For these reasons, it is clear why warfighters supported by slow and unreliable processes want to have large quantities of supplies on hand "just in case."

The Limitations of Mass

Yet there are limitations to a mass-based approach to logistics. Mass brings with it chronic problems in responsiveness, reliability, and efficiency. Having massive stockpiles on hand has not guaranteed that combat forces will get what they need when they need it. It is impossible to correctly anticipate all demands, and as soon as an unanticipated demand occurs, nothing can be done to satisfy it swiftly because the system's basic processes are slow. A mass-based system is not quick or reliable. In the early 1990s, it took a month, on average, for an Army mechanic to receive an ordered part if it was not available on his installation.

Mass in the system slows everything down. This is true in commercial operations as well. Consider a manufacturer with five serial workstations that can make several different types of products. To ensure that they always have something to work on, the manufacturer schedules lots of production and keeps "piles" of work-in-process inventory (WIP) in front of each station. Inevitably, it sometimes finds that a customer has a special request that can't be filled from stock. If the order is put into the system in the normal flow, it will take a long time to produce because it will be sitting behind lots of WIP in long queues before entering each workstation. In an attempt to be responsive to customer needs, the manufacturer could expedite the special request and walk the items to the front of each line at each workstation. This would be costly, but it would probably be necessary. It would also slow everything else down. Because forecasting is difficult and lead times are long, such expediting will have to occur to meet special demands. Once there is too much expediting, though, very little is truly expedited. Mass clogs the system, and work cannot flow smoothly.

Mass requires a great deal of manpower to manage and control, and more mass is much more difficult to manage, control, and protect than less mass. With large stockpiles of mass, it can become difficult even to find the right things. General Pagonis acknowledges that 28,000 of the 41,000 shipping containers that arrived in the desert had to be opened in order to determine their contents.

Moreover, mass begets mass. The amount of material sent into a theater of war is related to the number of people being sent into the theater—and, conversely, the number of people sent into a theater is directly related to the amount of materiel sent into a theater. To continue the example from the Gulf War above: Because an additional 21 days' supply of ammunition was moved forward to support the flanking movement, 17,850 additional truckloads were required. Each of those truckloads consumed fuel, oil, tires, etc.; each required a driver. Each driver required food and water, medical supplies, a place to be quartered and fed, and the support of medical personnel, military police, clergy, etc. The ripple effect is obvious—and onerous. And for each of these support personnel, still more additional provisions, materiel, and support personnel are required.

The mass-based approach to logistics is inherently expensive. The costs of a "mass"-based logistics system are far greater than the cost of the mass itself. Producing, delivering, storing, and managing mass consume vast resources. The many logisticians that are need-

● Mass begets mass.



ed to manage and control that mass are only a part of the cost. They in turn must be supported, further increasing personnel costs and adding to the consumption of items like fuel and food. There is also the cost of returning all this materiel and humanity to the United States, as well as the time that these people are not available for more productive activities.

Beyond the costs of the people, provisions, and materiel is the cost to the warfighter in terms of footprint, risk, and mobility. Large stockpiles make attractive targets and must be protected. To the extent that warfighters value quick deployment, high mobility, and rapid maneuver, they would rather not have piles of mass pushed forward into their areas of operation. These forward piles limit tactical and operational mobility and can interfere with operations. The need to establish forward piles consumes strategic mobility, drawing on the transportation capacity that could be moving additional combat forces. Warfighters do not want the combat "tooth" of their forces to be constrained by the ponderous logistics "tail" that results from a mass-based logistics system.

Replacing Mass with Velocity

Because of the many limitations of mass-based logistics, the Army has signaled its intent to move away from this approach. In October 1999, the current Chief of Staff, General Eric K. Shinseki, unveiled a new Army vision statement that included the intent to "aggressively reduce our logistics footprint" in the warfighter's area of operations. The Chief noted that the Army could reduce this footprint in part by reducing the demand for logistics support—for example, by making vehicles more fuel efficient. But he pinned his main hopes on streamlining the logistics processes themselves: "[We will] revolutionize the manner in which we transport and sustain our people and materiel."³ The new Army vision implies a much leaner logistics system than today's, one that is faster, more reliable, more accurate, and more affordable.

There is an alternative to mass-based logistics that avoids its limitations. The alternative is to improve the speed and reliability of support processes so that customers of the logistics system can receive what they need when they need it without having massive stocks in the area of operations. In short, the alternative to mass is velocity.

3 The Army's vision statement is accessible at <http://www.army.mil/armyvision/armyvis.htm>.

Velocity Management, the Army's initiative for moving away from a mass-based logistics system, began back in 1995, before Shinseki articulated his vision.⁴ As the name "Velocity Management" implies, the initiative seeks to replace the traditional reliance on mass with the modern business concept of high-velocity processes tailored to meet evolving customer needs. This solution to the problems associated with a mass-based approach is the same for the Army logistician and for his commercial counterpart, the clothing retailer. The retailer also needs to reduce lead times. He can still use the same inevitably wrong forecast, but he need only order enough for, say, the first two weeks. To the extent that the forecast holds, the retailer can then still get the same items as long as the supplier can quickly provide replenishments. To the extent that the forecast is wrong, the supplier can adjust and send the right things.

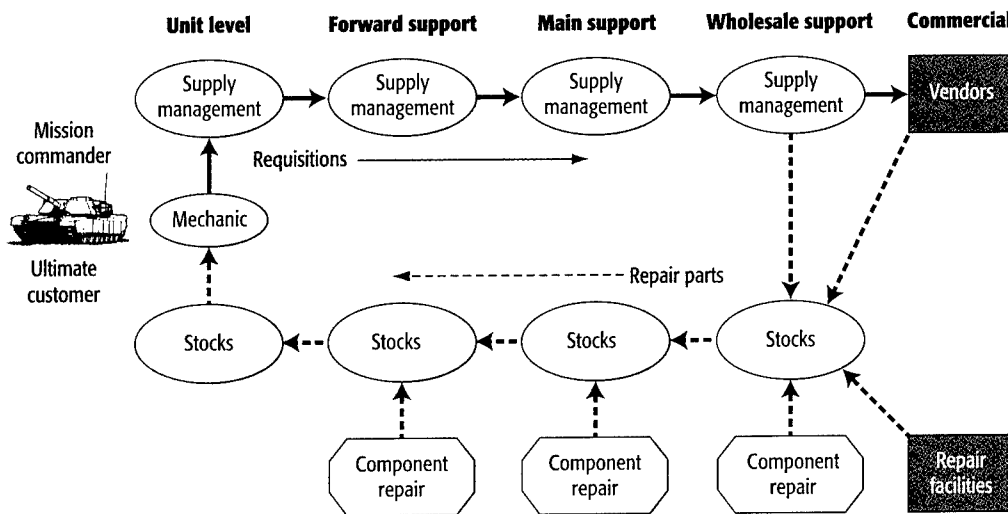
Under a velocity-based approach to logistics, the logistics system satisfies the support needs of customers through the agility and responsiveness of its processes rather than through massive stockpiles and other resources kept on hand "just in case." Both information and materiel flow faster and more accurately, and at lower total cost. Customers primarily measure system performance not in terms of days of supply, but in terms of response time and reliability; not how much a unit needs to lug about, but how quickly and certainly the system can deliver what is needed.

The traditional mass metric of "days of supply" reflects the belief that more and larger piles of mass are needed to cope with uncertain demand patterns and uncertain supply performance. By contrast, the movement from a mass-based logistics system to a velocity-based logistics system requires metrics that focus on time. In particular, a metric is needed that captures how long it takes from the time a customer orders an item to the time the order is filled. This is termed customer wait time (CWT). CWT has three components.

- **Order time:** how long it takes to place an order.
- **Backorder time:** how long before the requested item is available (for in-stock items, this component is zero).
- **Shipping time:** how long it takes to ship the item to the customer.

● Velocity Management seeks to replace the traditional reliance on mass with the modern business concept of high-velocity processes tailored to meet evolving customer needs.

4 The term and concept were developed by RAND in research sponsored by the Army's Deputy Chief of Staff for Logistics.



● **Figure 1** The logistics system consists of processes for delivering support services and materiel to warfighters

CWT provides an aggregate measure of the performance of a variety of logistics processes. It will vary according to what is stocked locally; what is stocked at other locations; how long it takes to either repair items or procure items that are not in stock; how long it takes to process and ship material; how long it takes to receive and process shipments; and so on. As a result, CWT is a high-level metric that can be used to drive improvements in processes throughout the logistics system.⁵

The schematic in Figure 1 presents the view of the logistics system as a set of processes—in commercial terms, a supply chain—that deliver products and services to customers, such as spare parts and equipment maintenance. The figure focuses on the processes associated with providing the spare parts needed to maintain weapon systems. Among them are the order fulfillment process, the repair process, the inventory determination process, and the procurement process, plus the process for managing the financial transactions associated with most of these activities. As the figure suggests, the Army's supply chain is complex and cuts across the public and private (i.e., commercial) sectors. Within all processes, many key activities are performed by non-Army and even nongovernment organizations.

⁵ The *Department of Defense Strategic Logistics Plan 2000* stipulates customer wait time as the primary metric of the logistics system. The Army's measurement of CWT is illustrated in Chapters 2 and 3.

Through Velocity Management, the Army is compressing the cycle times and reducing the variability of key logistics processes such as ordering and shipping materiel and repairing equipment and components. Even the financial management processes for logistics are becoming faster and more accurate. The Army is streamlining all these processes by eliminating the non-value-adding activities (such as stops at intermediate destinations before delivery) and by continuously improving the value-adding activities (such as simplifying warehouse layouts and improving the communication between management information systems in different organizations). Logistics processes are becoming "faster, better, and cheaper."

As processes become faster and more reliable, the Army can redesign its logistics system to minimize its footprint in an area of operations. As supply times become faster and more reliable, inventory levels can become leaner without increasing risk. This creates further opportunities for improvement. For instance, consolidation and containerization points outside the area can package customized shipments of provisions and supplies so that logisticians can meter them precisely to the customers who need them and so that they require minimum handling in the area of operations.

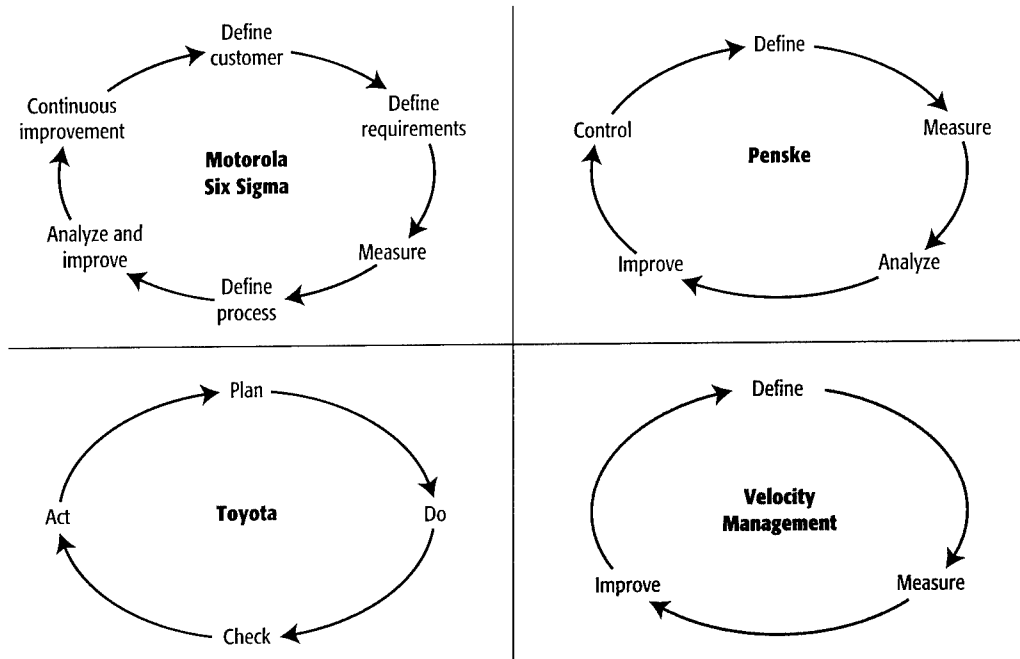
Define-Measure-Improve

The goal of Velocity Management is to provide the Army with a logistics system that, while tailored to the military, performs as well as a first-class commercial supply chain. Replacing mass with velocity in a logistics system as large and critical as the Army's is an organizational change of great difficulty. To make the transition, the Army has applied proven techniques that systematically and continuously highlight opportunities for improvement. To foster and guide their improvement efforts, leading commercial firms have institutionalized systematic methodologies. Famous examples include Toyota's four-step method and Motorola's six-step method.⁶

To implement Velocity Management, the Army has institutionalized an analogous improvement method consisting of three steps: Define the process, Measure the process, Improve the

6 The four steps are Plan-Do-Check-Act; PDCA is also known as the Shewhart cycle, after Walter Shewhart, the "father" of statistical quality control. In Japan, PDCA is commonly called the Deming wheel, after W. Edwards Deming, the protégé of Shewhart who first introduced the ideas of statistical quality control to that country.

FedEx uses another quality improvement methodology with four steps (developed by Organizational Dynamics Incorporated): Focus-Develop-Analyze-Execute (FADE).



● **Figure 2** The D-M-I methodology is the Army's version of commercial change management approaches

process (D-M-I). (See Figure 2). Like its commercial analogs, D-M-I refers to a sequence of activities iterated in a continuous cycle. The activities in the first two steps, Define and Measure, create the additional expertise that is needed for better performance and identify the best targets for improvements based on customer needs. The third step, Improve, applies that increased expertise to achieve superior results at the same or less expense. The steps then iterate to ensure that the desired results are being achieved, to drive further improvement, and to keep initiatives aligned with evolving customer needs.

The next few paragraphs explain the activities and contributions of each step in further detail.

Define the Process

"Define," the first step, emphasizes the need to understand a process fully from end to end before embarking on an improvement effort. The Define step identifies the customers of a process and what outputs they need. It specifies what they value about these outputs: this information is required in order to avoid the common error of wasting resources on so-called improvements that no one outside the process will notice or can appreciate. In addition to customers and outputs, the Define step identifies the inputs to the process. Finally, defining the process also requires breaking it down into segments or subprocesses and identifying the

activities within each subprocess that transform inputs into outputs. (See Figure 3.)

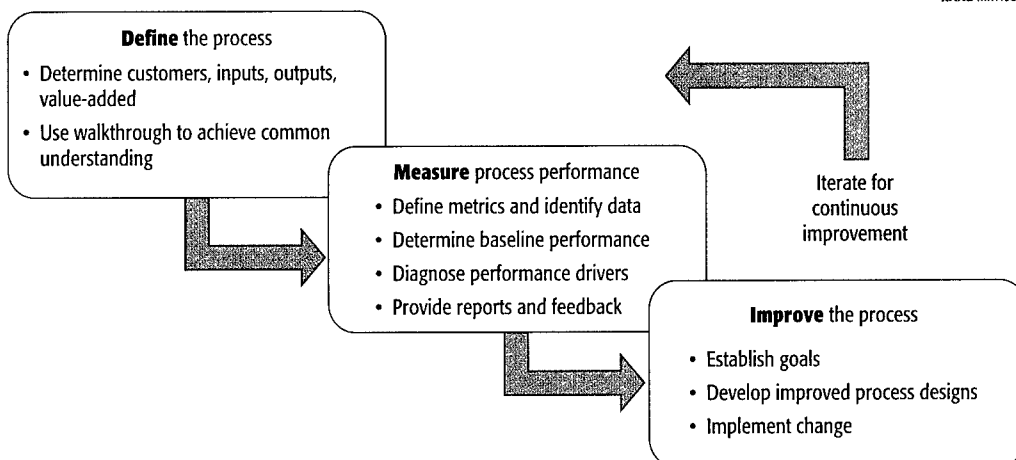
Typically, a logistics process involves several organizations. Key activities are performed by non-Army and even non-DoD (Department of Defense) government organizations as well as by commercial firms. For example, when an Army mechanic needs a spare part, a contractor may place the order. If the part is not available anywhere on the installation, a DoD organization outside the Army directs the order to another source of supply. The item may be shipped from a government-owned distribution site or directly from a commercial vendor. Within the continental United States, the ordered materiel will be carried by a truck or plane operated by a commercial firm. It may be received and receipted on the installation either by a soldier or by a contract employee. So what might be called the Army's order fulfillment process is not Army-owned: it cuts across many organizations in both the public and commercial sectors.

To increase expertise about a process as it is currently performed, experts representing all its segments and stakeholders should convene to pool their knowledge. From this base, the experts can develop a common, improved understanding of the entire process by conducting a detailed end-to-end walkthrough of the process, mapping it as they proceed.

Groups of experts participating in such walkthroughs are often surprised to discover that they have different and limited individual views of the same process. While many believe they are familiar with the entire process, they often find that they are ignorant or misinformed about the details of segments other than their

● **Figure 3** The D-M-I methodology leads to continuous improvement

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own. Frequently they learn that previous improvement efforts that were focused only on particular segments of the process may have been working at cross-purposes. For instance, a transportation manager might be encouraged to ensure that cargo planes are filled to capacity, even if this means holding some cargo for days until a full load is available. Further downstream in the process, however, this decision might create delays, costs, or risks that could far outweigh the costs of scheduling additional flights. An end-to-end view is needed to coordinate improvement efforts throughout the process and avoid optimizing individual segments while sub-optimizing the effectiveness and efficiency of the process as a whole.

Measure the Process

"Measure," the second step, complements the Define step by increasing a second kind of expertise about the process targeted for improvement. Whereas the Define step aims to improve knowledge about how the process is done, the Measure step aims to improve knowledge about how well it is done.

● Under Velocity Management, improvement is sought on three dimensions of performance: time, quality, and cost.

Under Velocity Management, improvement is sought on three dimensions of performance: time, quality, and cost. That is, VM seeks to make logistics processes simultaneously "faster, better, and cheaper." To support measurement on each of these dimensions, metrics must be developed that reflect what the customers of the process need and value. The metrics should be robust against gaming; that is, only desired behaviors should produce improvements in the metrics. To support measurement on each metric, appropriate data must be collected and analyzed, and performance reports must be devised and tested.⁷ (See Figure 3.) The choice of metrics is critical because what gets measured and reported is what gets attended to.

As the acronym "D-M-I" suggests, measurement is the central mechanism to motivate, guide, and sustain improvement. Measurement helps to identify performance problems, facilitates diagnosis of the causes of these problems, monitors the effects of process changes to improve performance, and provides feedback to those implementing the changes. Measurement documents the effectiveness of improvement efforts with very compelling evidence. For this reason, measurement reporting helps build support and maintain momentum for reform efforts.

⁷ To date, the Velocity Management initiative has been able to rely upon existing data in the Army's management information systems, thus avoiding the expense of special data-collection activities.



Improve the Process

"Improve," the third step of the D-M-I process, capitalizes on the increased expertise developed during the first two steps. Armed with a deeper understanding of the process "as is," with an improved capability to measure performance, and with an improved understanding of customer needs, experts on the process can devise changes that are likely to improve its performance.

The measurements tell the teams which processes and sub-processes they should examine in more detail and which ones present the best opportunity for improvement. More fine-grained measurements give the team clues about what they should be looking for when walking the process at a particular site. What do they look for? What types of things do they change? Generally, they look for activities that are wasteful or that add little value, on large scales and small:

- Unnecessary motion (e.g., warehouse personnel having to walk to the other end of the warehouse for a very frequently ordered part or a mechanic continually walking across a shop to get a tool).
- Unnecessary transportation (e.g., dropping off items for a high-volume customer at a central receiving point for pickup by the customer, rather than delivering them directly).
- Long periods of waiting (e.g., waiting several days for a truck to fill up or not synchronizing processes).
- Large stocks of inventory (a sign of long lead time or high variability).
- Overprocessing (e.g., shipping on premium transportation when a less expensive mode is just as fast and reliable).
- Overproduction (e.g., making or repairing unneeded or excess items).
- Multiple handling.
- Activities and materiel whose purpose workers cannot immediately explain (e.g., why is this package here?).
- Mistakes.

Frequently when a team identifies a non-value-added activity, it cannot simply eliminate the culprit immediately; rather, the elimination must be combined with other complementary improvements to the process. This is because the non-value-added activity might be necessary within the context of the unimproved process. For example, inspection may be a necessary step in low-

● World class organizations . . . are almost compulsive about measurement.

—Council of Logistics Management



quality processes. In such a case, a team intent on eliminating the inspection step would first have to figure out how to improve process quality. Once that was done sufficiently, then inspection could be reduced or eliminated.

Besides identifying non-value-added activities, the teams also look for opportunities to improve value-added ones. For example, rather than manually receipting items into a computer, a bar code scanner can be used. Perhaps an inventory algorithm that leads to improved service could be implemented. Instead of a depot's sending lots of packages by premium overnight courier to an installation, all could be sent on a daily truck at lower cost and the same speed.

Teams at selected sites implement process changes to test how well they work. The effects of these changes are monitored and reported to the implementation teams to motivate further improvement and suggest refinements. Then the intervention can be documented and implemented at other sites.

The process experts also use the metrics identified in the Measure step to articulate realistic but challenging goals for improved performance. Progress toward these goals will occur incrementally. But often, early in the improvement of a specific process, a few quick, easy changes can be undertaken almost immediately for a big payoff. Besides the benefits to performance, these initial improvements kick off the reform effort in a way that energizes subsequent efforts.

As the performance is improved, the D-M-I cycle begins again, with a remapping of the changed process, continued measurement, and additional process changes.

Organizing for Improvement

Because of the complexity of Army logistics processes and the many diverse stakeholders, the Army recognized the need for high-level commitment and a strong organizational structure to ensure the success of the Velocity Management initiative. The initiative is guided and sustained by a coalition of senior leaders called the Velocity Management Board of Directors or simply the Velocity Group (VG). A "Logistics Triad" of three Army general officers (the Army's Deputy Chief of Staff for Logistics, the Deputy Commanding General of Army Materiel Command, and the Commanding General of Combined Arms Support Command) forms the nucleus of the VG. The coalition also includes other stakeholders in the Army's logistics system, both customers and

● Increased understanding coming from more accurate measurement leads to improvement pressure and specific improvement initiatives.

—Carl G. Thor

providers, not only within but also outside the Army. For example, it includes senior representatives from U.S. Army Forces Command, U.S. Army Europe, U.S. Forces Korea, the Defense Logistics Agency (DLA), and the U.S. Transportation Command. The senior-level commitment embodied in the Velocity Group has proved critical to aligning the many functions and organizations involved in each logistics process, including those activities that fall outside the Army's direct control.

One of the Triad, the Commanding General of the Combined Arms Support Command (CASCOM), acts as the Army's Executive Agent for the implementation of Velocity Management. A small group at CASCOM is responsible for coordinating VM implementation and continuous improvement activities across the Army and for serving as a clearinghouse for VM-related information.⁸ Several times a year they organize an Armywide meeting in which the VG receives updates on implementation progress and provides assistance and guidance.

The coalition approach to organizing for improvement is repeated at levels below the general officers and senior managers. Because Army logistics processes cut across organizational boundaries, and because every segment is technically complex, no single organization or individual has sufficient knowledge or control to make dramatic change. Teams of technical experts and line managers drawn from all segments of a process must be established in order to apply the D-M-I method.

VM is implemented by teams of two types: Armywide Process Improvement Teams (PITs) and Site Improvement Teams (SITs) at each installation. The combination of PITs and SITs is designed to implement VM as rapidly as possible by improving processes at individual installations and across the Army simultaneously.

A PIT is an Armywide team composed of technical experts representing all segments of a process; the team also includes Army and RAND Arroyo Center analysts. In accordance with the D-M-I method, PITs are charged with walking through their respective processes to establish common, detailed definitions; developing processwide metrics and performance reports; conducting analyses of current performance; and recommending process changes designed to improve performance. The leader of each PIT is a general officer or civilian equivalent in the senior executive

● To my knowledge, no company has attained world-class quality without upper management leadership.

—J.M. Juran

8 For example, they maintain a Velocity Management Web site at the CASCOM homepage, <http://www.cascom.lee.army.mil/vm/>.



service. Thus far, the Velocity Group has commissioned four PITs focused on improving key logistics processes:⁹

- Customer Wait Time PIT,¹⁰ led by the Deputy to the Commander of CASCOT.
- Repair Cycle PIT, led by the Commanding General of the U.S. Army Ordnance Center and School.
- Stockage Determination PIT, led by the Commanding General and Commandant of the U.S. Army Quartermaster Center and School.
- Financial Management PIT, led by the Deputy Assistant Secretary of the Army for Financial Operations.

A SIT is an installation-level team composed of local technical experts and managers. Each installation in the Army has established a Velocity Management SIT. These teams apply the D-M-I method to local processes and serve as a mechanism for the PITs to implement improvements Armywide. As participants in an Armywide initiative, they are able to consult directly with the VM implementation cell at CASCOT, as well as with the four PITs, for implementation guidance and assistance.

At RAND Arroyo Center, research on Velocity Management is conducted and managed in ways that support and extend the Army's implementation efforts. The PITs formed by the Velocity Group include RAND analysts among their membership, and RAND conducts analyses for the PITs to help identify specific process improvement opportunities and solutions. The research style is highly interactive and often collaborative with the Army. The analyses help to identify potential improvements to logistics processes and also provide technical support as the changes are implemented and evaluated. Figure 4 depicts the interactions among the Velocity Group, the PITs and SITs, and the research projects at RAND Arroyo Center.

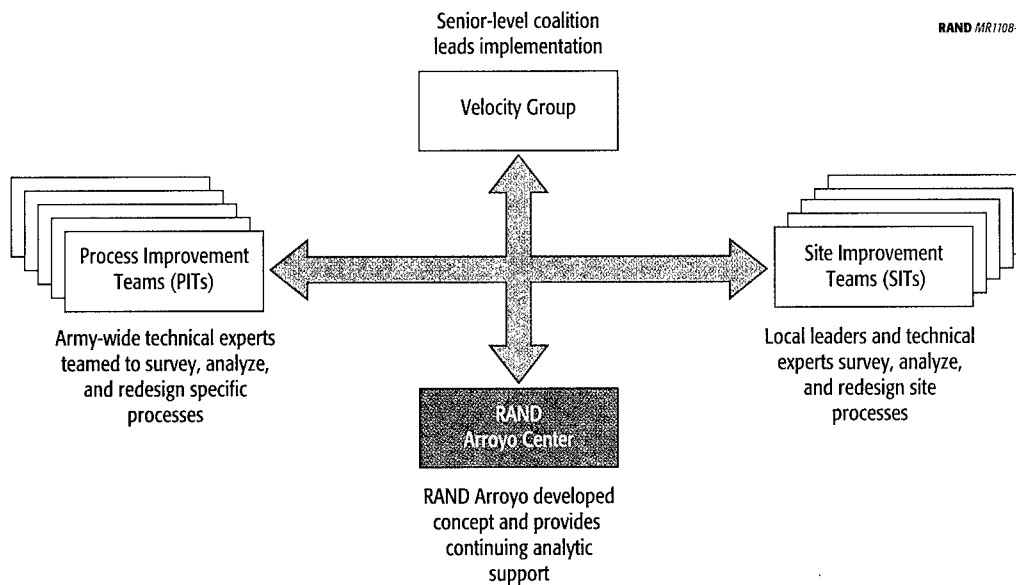
Organization of This Report

This report tells the story of the Army's Velocity Management initiative.

Chapter 1 has described the motivations, vision, organization, and implementation strategy that continue to make the VM initiative successful.

9 These are supplemented by VM PITs for the Army National Guard and for the U.S. Army Reserves as well as a Transportation PIT.

10 This team was originally called the Order and Ship PIT because of its focus on improving the order fulfillment process.



● **Figure 4** Improvements are driven from the top, made by teams, and guided by analysis

Chapter 2 describes the process changes that led to quick and impressive results in speeding the Army's order fulfillment process.

Chapter 3 shows how the Velocity Management initiative extended the D-M-I method from the order fulfillment process to other processes devoted to the repair of Army equipment, including the Army's inventory management, repair, and financial management processes. As a result, the repair process is experiencing fewer and shorter delays. These improvements, as well as cost savings arising from improved inventory management, mean that a broader array of ordered items is more readily available to Army customers. Financial information flows are more accurate and more timely.

Chapter 4 describes a new Army capability, analogous in intent to activity-based costing, for linking improvements in process performance to equipment readiness, the customer's key metric of satisfaction with logistics support.

Chapter 5 explains some of the mechanisms that the Army has used to sustain the Velocity Management initiative since 1995.

Chapter 6 is a short coda explaining how the Velocity Management initiative and other logistics reforms helped lay the groundwork for the new Army vision articulated by General Shinseki.

② Velocity Management in Action

The Army's order fulfillment process was the logical starting point for a major logistics reform initiative on two counts: it is important, and it was broken.

First, it is evident that the order fulfillment process is essential to the success of any Army operation. Indeed, logistics has sometimes been defined simply as "getting the right thing to the right place at the right time." The quick and reliable delivery of spare parts for weapon system repair is required to sustain equipment readiness. The unpredictability of failures, coupled with the criticality and high cost of many parts, makes the process for supplying them an ideal target for improvement.

Second, improvement was clearly needed. For decades, through peace and war, the Army's order fulfillment process had been plagued by a catalog of stubborn performance problems. Each segment of the process—from placing a requisition for an item to receiving the package, and every step in between—was not only slow, but also highly variable. Previous initiatives intended to remedy the problem had all failed to do so. The Army logistics leadership recognized the need to institute a whole new approach to change.

The successful effort to improve the Army's order fulfillment process provides a good illustration of the Velocity Management paradigm in action. In particular, it demonstrates how improvement teams employ the D-M-I method to build the collective expertise and coordination necessary to achieve and sustain dramatic improvement.

Improving the order fulfillment process required the participation of experts from many organizations, both within the Army and elsewhere. The Velocity Group commissioned a CWT Process Improvement Team to focus on activities of the order fulfillment process that cut across all installations and supply points and all information and transit resources. The PIT consisted of experts representing each segment of the order fulfillment process. These experts included maintainers, transporters, and inventory managers, as well as representatives from non-Army stakeholders

● The successful effort to improve the Army's order fulfillment process provides a good illustration of the Velocity Management paradigm in action.



such as the Defense Logistics Agency, U.S. Transportation Command, and government contractors (e.g., J. B. Hunt Trucking, FedEx, and Emery).¹

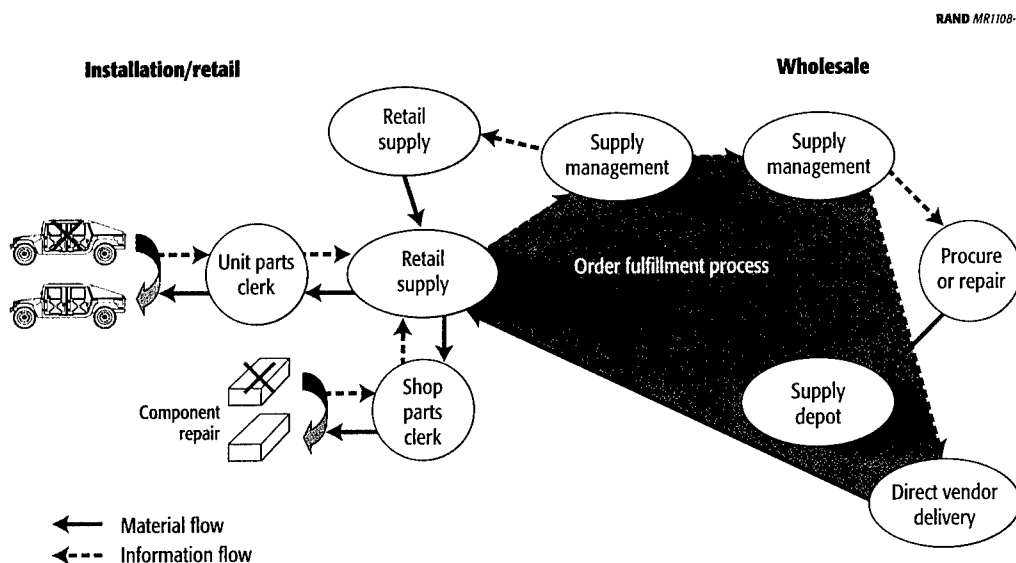
Defining the Order Fulfillment Process

"Define," the first step of the VM process improvement methodology, aims at producing a clear picture of the order fulfillment process that is common to all participants and stakeholders.

The order fulfillment process provides all parts needed for repair and support of weapon systems. The parts might be available at a number of locations in the Army. Some are available in the local warehouse, called the Supply Support Activity (SSA), which provides customers with the shortest wait time of all sources of supply. Occasionally, when an item is not available at the customer's local warehouse, another warehouse on the same installation is able to fill the order. If the part is unavailable at all warehouses on the installation, the order is passed to what is referred to as the "wholesale" supply system.² That is, it is passed to a national-level item manager who sends it to the appropriate supply depot or to a commercial vendor for fulfillment. The wholesale supply system is the largest source of spare parts, filling nearly 60 percent of all orders.

Figure 5 provides a schematic view of the order fulfillment process for Army units in the continental United States. Figure 6

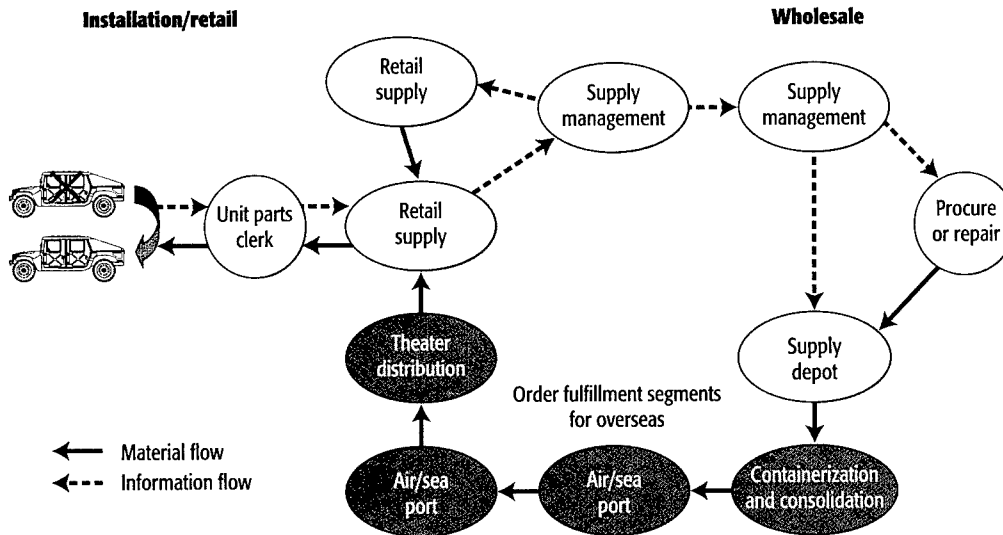
● **Figure 5** The order fulfillment process from wholesale depots is central to the Army's supply chain



1 For more detailed discussions of the Army's improvement of the order fulfillment process, see Girardini et al. (1996) and Wang (2000).

2 Local supply points on Army installations comprise the "retail" level of supply.

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● **Figure 6** The order fulfillment process for Army units abroad has additional segments

provides the same view of the process for units stationed abroad: this is longer and more complex due to the need for movement of materiel to the port of debarkation, change of transportation mode prior to the ocean crossing (by plane or ship), and subsequent movement from the point of embarkation to the Army unit's position in the theater of operations.

The CWT PIT focused initially on the order fulfillment process for orders filled by supply points in the wholesale system. It defined this process as a cycle that begins at the retail supply organization with an order for a part to be filled by a wholesale supply depot or, rarely, by direct delivery from a vendor. This cycle ends at the same point when a supply clerk receives the part. The order fulfillment process includes activities such as ordering, sourcing, picking, packing, shipping, delivery, and receipting.³

To improve their understanding of the order fulfillment process, members of the CWT PIT and of installation SITs literally walked each step of the process. These walkthroughs extended from the point when the need for a part is identified until the point when the part arrives in the hands of the mechanic who is going to install it on the equipment. They observed and analyzed all information processing, distribution, and materiel-handling

³ Backorders refer to requests that are not available for release from wholesale sources of supply at the time the request is received. While backorders of parts at the wholesale level are an important issue and one that VM addresses, the order fulfillment process as defined is focused only on fulfillment orders when the part is available for issue ("on the shelf") in the wholesale system.

segments along the order fulfillment process. Walking the process cut across many Army and other organizations, both military and commercial ones, and included visits to inventory control points, wholesale supply depots, and Army installations.

Measuring the Order Fulfillment Process

Once the process was defined, it was necessary to determine the best way to measure it to foster improvement.

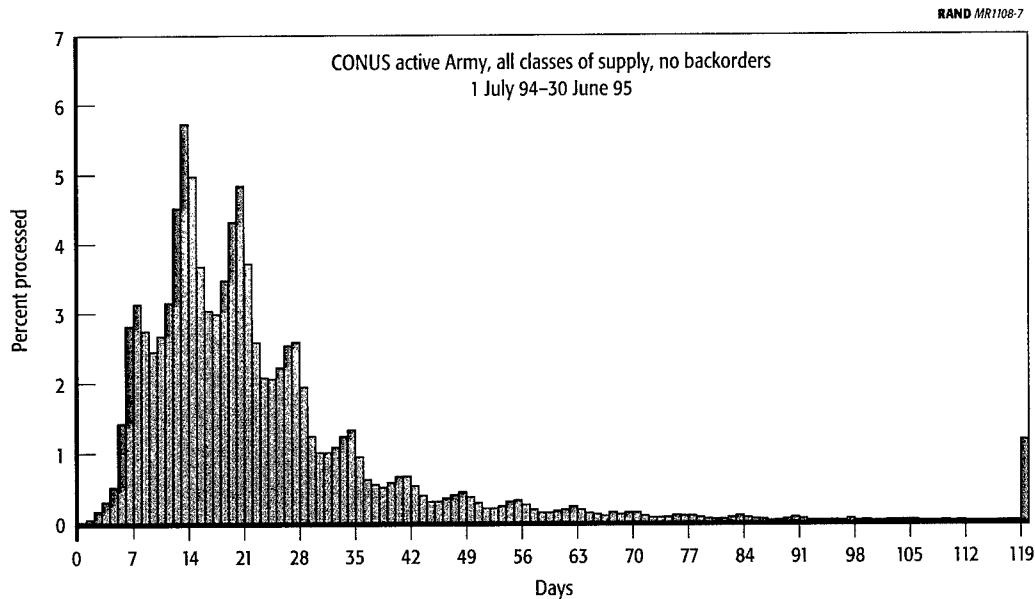
During walkthroughs, members of the VM teams found that many segments of the process were being managed with metrics that focused on local effectiveness or efficiency but did not necessarily result in good customer service. For example, in some segments of the process, organizations measured themselves by the efficient use of trucks, with the result that partial truckloads were held up until a full one could be assembled. While this goal and this metric yielded more efficient use of trucks, for many orders it delayed getting the needed part to the customer. There were other examples of conflicting goals that resulted in the apparent efficient use of some resources at the expense of overall process performance.

The CWT PIT focused initially on improving the time dimension of the order fulfillment process. This focus was facilitated by the existence of an Army dataset called the Logistics Intelligence File (LIF) that contained CWT data for orders for spare parts that were placed by Army units and filled by wholesale sources of supply (primarily DLA supply depots). These data permitted time measurement both of the process as a whole and of many individual segments. Because of its mandate to improve the order fulfillment process, the PIT focused on reducing CWT for items that were available to ship (i.e., nonbackorders).⁴

At the outset of the VM initiative, the Velocity Group requested that a baseline be established against which to evaluate the success of subsequent improvement efforts. RAND analysts used LIF data to analyze the Army's CWT performance during the year immediately preceding the initiative. The baseline period extends from July 1, 1994, to June 30, 1995. Analysis of CWT performance during the baseline period revealed several critical features of the order fulfillment process (see Figure 7).

The average CWT was known to be very long (almost a month), and this was recognized to be slow compared to order

4 Before the introduction of the CWT metric, the Army referred to the fulfillment time for such orders from the wholesale supply system as "order and ship time" (OST). Other services commonly referred to it as "logistics response time" (LRT). These metrics were measured both with and without backorders.



● **Figure 7** Six years ago, CWTs were extremely long and variable

fulfillment times in the commercial sector. However, the Army had not recognized that its CWT performance was also highly variable.

As the figure shows, the distribution of CWTs was widely scattered. Many requisitions were filled in the first weeks, but the distribution had a very long “tail” representing requisitions with very long CWT.⁵ From the perspective of Army customers of the order fulfillment process, this variability meant that the process, although occasionally fast, was very undependable. Even though the tail was a small fraction of the total requisitions, such unreliability clearly drove many of the Army’s counterproductive coping behaviors: mechanics will wait a couple months for a part only a few times before they begin placing duplicate orders for parts, hoarding parts, or finding alternatives to the standard supply system. Moreover, the extreme variability made it difficult for maintainers to repair equipment in a timely fashion. This is because a repair job typically requires multiple parts, and the repair cannot be completed until every part is received. If even one part for a job lies in the tail of the CWT distribution, the job will have to wait for that part to arrive.

Both the speed and the reliability of the order fulfillment process needed dramatic improvement, yet the Army’s traditional

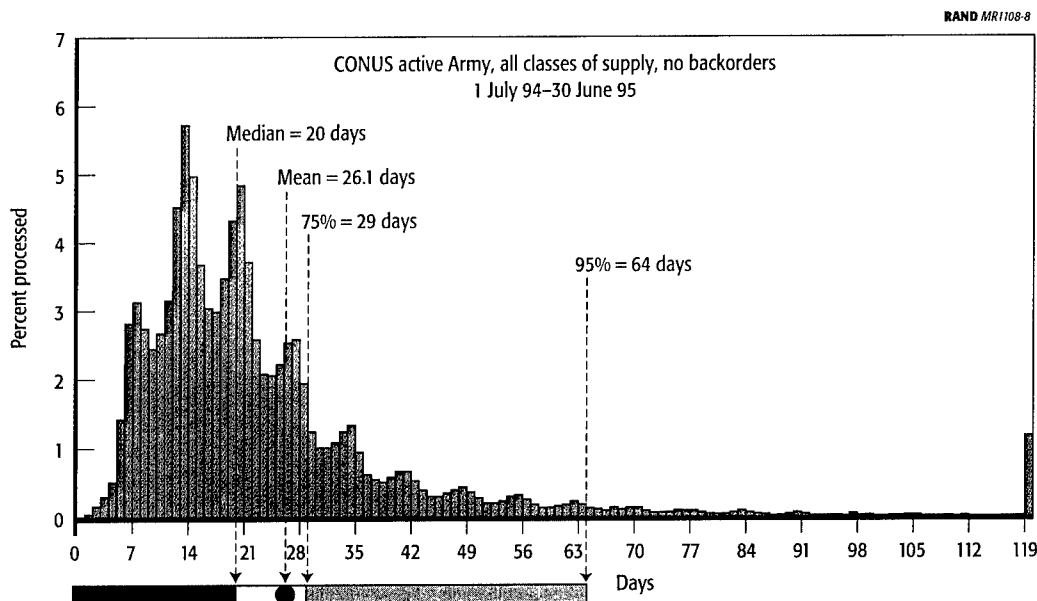
5 There are also lesser periodic peaks that are due to weekends (because requisitions that arrive over the weekend are not processed until the following weekday).

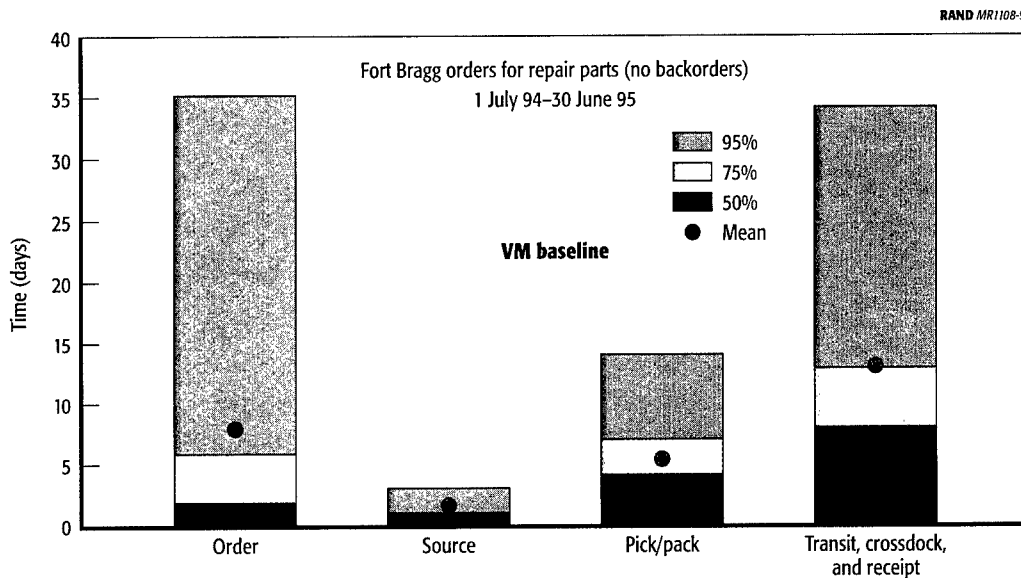
metric, mean (i.e., average) CWT, captured neither of these performance aspects well. The mean CWT, as a single number, masked the underlying variability of the process and did not accurately represent its typical performance.

The CWT PIT recommended a new suite of CWT metrics, which the Velocity Group then approved for implementation. The new metrics depicted both "typical" (median) performance as well as performance variability, and they could better characterize the customer's perspective on how the process performed. For instance, if a customer orders four parts, he is not likely to receive them all on the same day that corresponds to the average CWT. Rather, parts arrive over a number of days, depending upon their availability, source, and mode of shipment, among other factors. So of the four parts, one might arrive in just a few days, while the last one may not arrive for several months. The 50th percentile metric indicates the median CWT, that is, the time by which half of the ordered items arrive. Likewise, the 75th percentile indicates the CWT by which three-quarters of the ordered items arrive. The 95th percentile indicates the time by which all but the last 5 percent of orders arrive. The 75th and 95th percentile metrics help focus efforts on reducing the wide variations in delivery time for orders that take the longest time to be filled and delivered.

These new metrics for measuring CWT performance, supplemented by the traditional metric of mean CWT, have become standard in Army reports. They are displayed in Figure 8. Because the distribution curves are unwieldy for making comparisons, the

● **Figure 8** New metrics helped to highlight variability in CWTs





● **Figure 9** All segments of the order fulfillment process showed delays

Army began using overlaid bar charts to display the CWT metrics more compactly. By way of illustration, one of these bars appears horizontally below the distribution in Figure 8.

Because the Army's LIF data measure performance within segments of the order fulfillment process, further analysis was able to reveal a second critical feature: during the VM baseline period, the slow and variable performance that characterized the process as a whole was not confined to a few segments but was present in all segments. This segment analysis is shown in Figure 9 for orders from one illustrative installation, Fort Bragg, during the baseline period. (The overlaid bar presentation introduced in Figure 8 has been rotated so that tall vertical bars represent poor performance.) Although the data permit a finer-grained segmentation, here the process is divided into just four segments: placing the order, sourcing the order (i.e., directing the requisition to a source of supply), picking and packing the order, and shipping and receiving the order. As the height of its bar indicates, even the sourcing segment, which is largely an administrative and automated function, had room for improvement.

It was surprising to many in the Army to learn that the initial and final segments showed the longest delays. They had assumed that the chief reasons for long and variable CWT would be found elsewhere in the order fulfillment process, in the poor performance of organizations outside the installation. It did not occur to them that the installation's own ordering and receiving activities might

be major contributors. Yet investigation revealed that ordering could be substantially delayed by manager reviews of individual requisitions and various financial management issues. On the positive side, these first and final segments were those over which the Army itself had the most control, so it was feasible to improve them quickly through unilateral efforts.

Improving the Order Fulfillment Process

The third stage of D-M-I, "Improve," involves combining the end-to-end understanding of the process developed in the "Define" stage with the diagnoses of the sources of performance deficits that were isolated in the "Measure" stage. In support of the CWT PIT, RAND researchers analyzed the LIF data associated with the metrics to help diagnose performance problems and identify potential sources of delay. Another tool used successfully by the SITs was a report that listed each requisition whose CWT lay beyond the 95th percentile. These "outliers" were researched individually by personnel operating in each segment of the process to identify and eliminate the sources of such extraordinary delay.

The PIT discovered that many factors contributed to the long and highly variable CWTs. Some of these were easily fixed at the local level, without increasing total costs, and resulted in quick "wins" for the VM initiative. For example, Army installations strengthened oversight, simplified rules, improved the performance of new requisitioning and receipting technologies and increased their proper use, reduced review processes, and streamlined on-post delivery. To understand and monitor the effects of these process changes, they made use of the information available from the new metrics.

Other changes required establishing partnerships with the organizations that controlled other segments of the order fulfillment process, such as the DLA (which operates many of the major supply depots) and commercial trucking and small package delivery firms. Analyses showed that much of the delay and variability in these segments reflected the use of a variety of shipping modes in an attempt to match each order with the lowest-cost shipping mode that was appropriate to its urgency and characteristics, such as size and weight. These modes included small package air shipments (e.g., by FedEx or other carriers), small package ground shipments (e.g., by United Parcel Service), dedicated trucks, and "less than truckload" shipments (in which DLA shipments are combined with shipments from others on a single truck). The mixing of shipping modes caused some orders to be delayed (for instance, to wait until enough similar orders accumulated to fill a truck) and

● Other changes required establishing partnerships with the organizations that controlled other segments of the order fulfillment process.

required the installations receiving the materiel to cope with multiple deliveries, most of them unscheduled.

The analyses suggested strongly that the delays and variability in the depot and transit segments could be greatly reduced if the Army and the DLA would establish regular scheduled trucks (similar to regular mail deliveries) as the primary shipping mode to large Army installations. Many of the routes between supply depots and Army installations had driving times of one day (in most cases two days or less). Moreover, the shipment volume on these routes was often sufficient to justify sending a truck daily or every other day.

On routes where such frequent trucks could be justified, the time for transportation and receipt became one or two days, matching the performance that would be provided by using a premium transportation service such as FedEx. Once dedicated truck schedules were established on these routes, even high-priority items that were formerly shipped by air could be placed on the trucks. By using scheduled trucks, the Army was able to achieve the speed and reliability of using premium transportation without the expense or the added trouble of meeting a second truck or receiving many individual small packages.

The use of scheduled trucks between the Army's major CONUS installations and their primary supply depots has spread widely under the VM initiative. Under the scheduled truck concept, depots that serve large installations place all the shipments for that installation, regardless of eligibility for air shipment or bulk considerations, on a routinely scheduled truck.

To increase its use of scheduled trucks, the Army has worked closely with the Defense Logistics Agency. DLA implemented a number of changes to increase the opportunities for capitalizing on scheduled trucks. DLA depots applied automation to sort packages into multipacks that streamlined the shipment and receipt of multiple items to a single installation and to specific locations on that installation. This permitted the scheduled trucks to bypass the central receiving point when they arrived on the installation and to deliver directly to customers by making a number of quick stops in a planned sequence.

To further speed delivery and receipt, DLA also increased the use of automated manifest cards for major customers on Army installations; these scannable cards indicating the contents of packages reduced the time and workload required to receive shipments and produce receipts.

Finally, DLA changed the stock positions at some depots to reflect better the needs of customers on the closest Army installa-

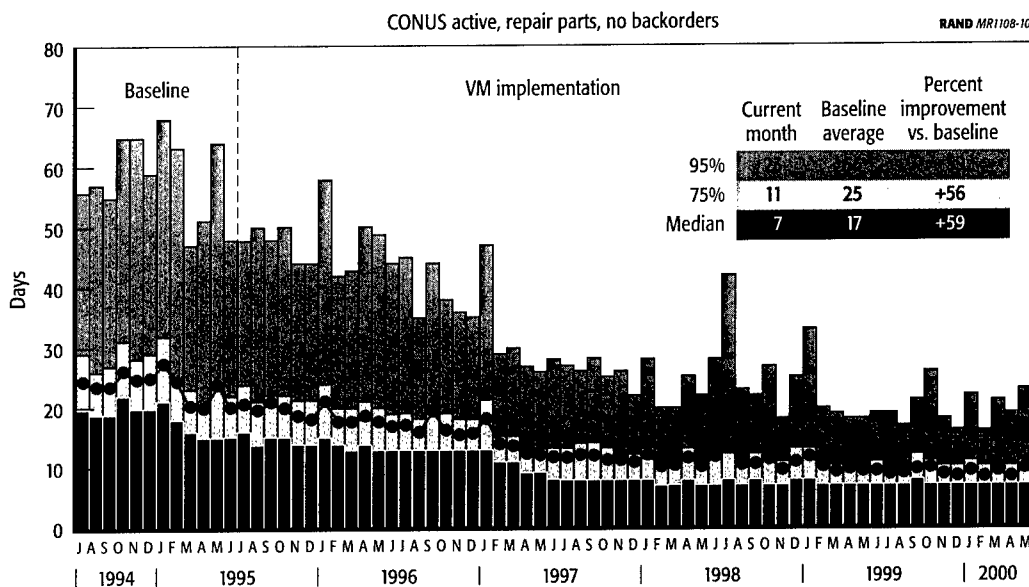
tions. Stocking a depot with more of the items that its major customers regularly order permits more volume to flow between these depot-installation combinations. Because this volume is added to scheduled dedicated trucks, as long as the trucks are not already full, it can be added at no additional transportation cost. In some cases volume has grown enough to increase the number of trucks that it is cost-effective to send per week. More frequent deliveries mean lower CWT.

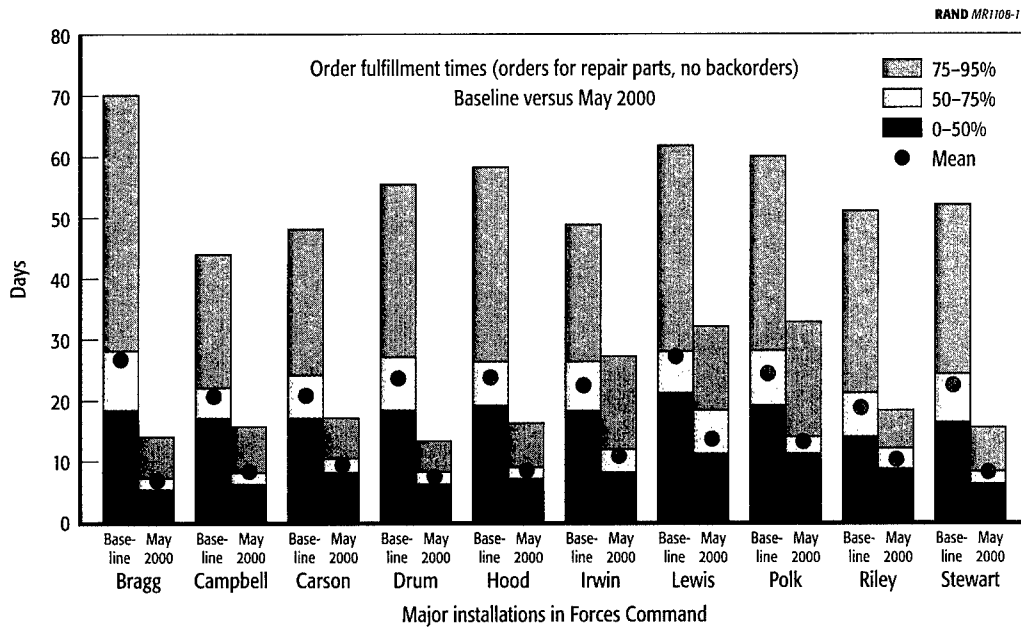
Installations made complementary changes. They redesigned delivery routes so that the scheduled trucks could efficiently make multiple stops on an installation. They improved the training of supply clerks on using automated receipting tools and worked with the supplier to improve their design and interoperability. They changed work schedules so that supply teams could meet scheduled trucks at specific points and unload deliveries very quickly, much like the "pit crews" of stock car racing. They redesigned their on-post distribution systems so that receipted supplies were more quickly distributed to the customers who needed them.

The result of these many improvement activities was a much faster, more reliable order fulfillment process. Figure 10 displays the improvement in CWTs for all active Army units in the continental United States that order spare parts from wholesale sources of supply. The improvement trend begins quickly, becomes dramatic, and continues.

Importantly, the improvement is not confined to high-priority requests or to a limited number of items that are targeted

● **Figure 10** Improved performance affects all orders for spare parts from the wholesale supply system



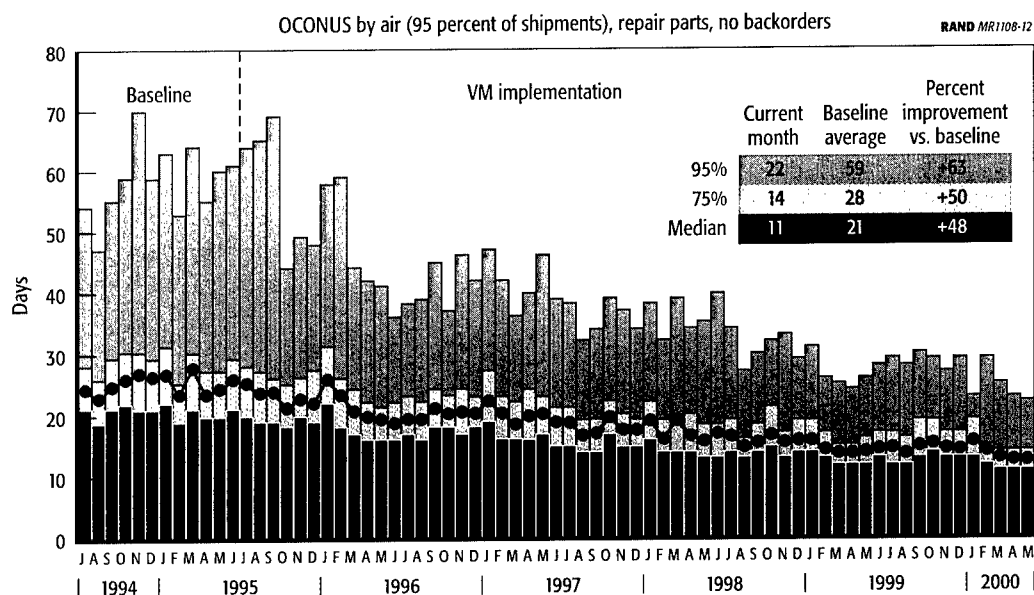


● **Figure 11** The Army has propagated improvements to the order fulfillment process across all installations

for expedited handling. Nor was the improvement confined to a limited set of customers of the process: the Army was able to replicate the successful reduction of CWT at all installations. Figure 11 illustrates this success by displaying the improvements at the major installations of U.S. Forces Command located in the continental United States. When Velocity Management was briefed to a gathering of chief executive officers of large commercial firms, this was the aspect of the Army's achievement that most piqued their interest.⁶ In an era of globalization, they all face an increased challenge to propagate their business reforms throughout many sites around the world. They were struck that the Army had met this challenge under Velocity Management, that it had been accomplished so quickly, and that no installations were left behind in the process.

Many of these actions also helped improve CWTs for units stationed and deployed outside the continental United States, as shown in Figure 12. This is because most of the continental segments of the order fulfillment process are also part of the process for units abroad. The streamlining of ordering, depot processing, and receiving activities contributes to the reduction of both CONUS and OCONUS CWT, as does the improved posi-

6 RAND, Washington, D.C., May 16, 1998.



● **Figure 12** Army units stationed and deployed overseas now receive parts twice as fast

tioning and sourcing of stocks to accommodate the needs of major customers of the depots.

One of the key concerns that warfighters have expressed about moving from a reliance on massive logistics resources to a reliance on very responsive logistics processes is whether the processes will remain responsive during wartime. As deployed units move into an area of operations, their demand for spare parts typically increases because of increased equipment usage. Moreover, the last segments of the order fulfillment process must be redirected and extended quickly to reach the units in their new locations. Could a very lean system flex and adapt in response to a shift in demand such as that associated with a military contingency? Would CWTs to the participating Army units remain fast and reliable, or would performance degrade, perhaps placing the units at increased risk?

These concerns have been answered positively. Since the Velocity Management initiative began in 1995, the United States has participated in several military operations that tested the capability of the improved order fulfillment process to support deployed Army units. Figure 13 compares how CWT performance has improved since the VM baseline period for Army units stationed and deployed abroad in each major theater of operation. The rightmost bar in the figure focuses on the CWT to troops deployed to Bosnia and Kosovo. It shows that these units receive the same fast and reliable CWT performance as others. This means that the Army was able quickly to develop a high-performing

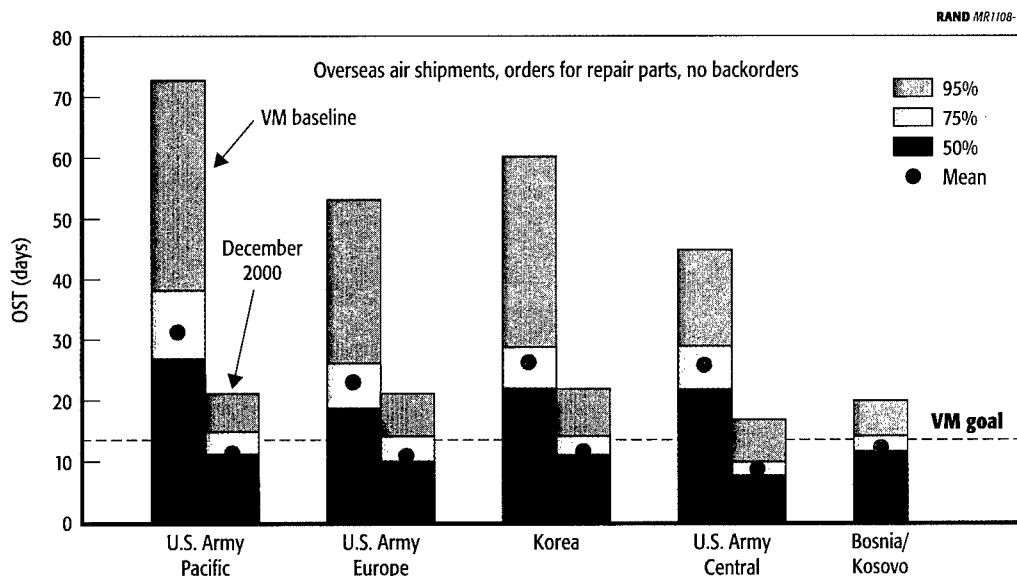
extension of its order fulfillment process (i.e., scheduled delivery to an airfield plus a distribution system within the area of operations) to support the deployed units.

As this chapter has shown, the Velocity Management initiative brought a powerful paradigm for improvement to the Army's order fulfillment process. Both the quick pace and the staying power of efforts to improve this process surprised many in the Army, who had grown accustomed both to living with poor performance and to being disappointed by efforts to improve it.

In June 1998, in recognition of the Army's success in speeding its order fulfillment process, the Combined Arms Support Command received Vice President Al Gore's Golden Hammer award from the National Partnership for Reinventing Government.

Encouraged by this success in improving the order fulfillment process, the Army moved quickly to extend the Velocity Management initiative to other key logistics processes in a systematic way. That is the subject of the next chapter.

● **Figure 13** The Army has sustained improved CWT when units deploy to new areas of operations



3 Extending the Paradigm

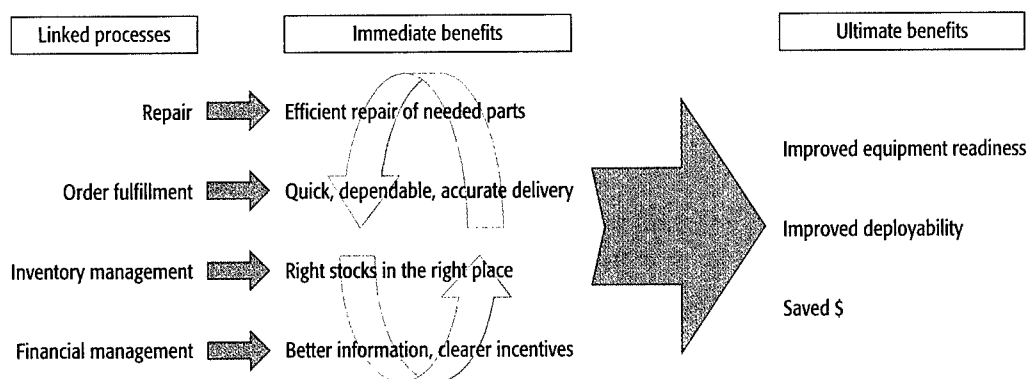
Success builds on success. Because Army logistics processes work together in a system, improvements in one process can lead to improvements in others. Dramatically decreased CWTs had beneficial effects on the performance of other Army logistics processes. Some of these benefits are displayed in Figure 14.

Consider the impact of improved CWT on the performance and cost of local inventories. Inventories can be said to “perform” well when they carry the items that their customers need and when they actually have on hand the items that they carry. Generally, the broader and deeper the inventory, the better its potential performance. But more inventory requires more investment, so performance must be balanced with cost.

As CWT becomes faster and more reliable, it creates the opportunity to develop higher-performing inventory without increasing cost. Faster CWT means faster replenishment of the inventory. When quick replenishment can be relied upon, supply points can reduce the depth of the inventory that is used to buffer against potential delays and unreliability in replenishments. Leaner stocks require less investment, freeing up resources for other uses. Some of these resources can be used to broaden the inventories to include items that previously were not available at local ware-

● **Figure 14** Improvements in one process lead to improvements in others

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houses. Broader inventories, in turn, perform better, in that they can satisfy more of their customers' requests. Customers will be able to have a higher proportion of their orders filled immediately by the closest, quickest source of supply. That dramatically improves CWT.

Improvements in the order fulfillment process and in the inventory management process both help to improve the repair process. A major source of delay in repairs is waiting for needed parts to arrive. As more orders are filled from local supply points, and as orders filled at the wholesale supply system arrive more quickly, the CWT, time that mechanics have to wait for parts, decreases. Repair cycle times are reduced, and weapon systems are returned more quickly to operational readiness.

The Army also recognized that delays, errors, and waste in these logistics processes could be further reduced by improving the quality and availability of financial information. For example, when logistics customers have timely, accurate financial records, they are less likely to hold up requisitions while they insure that sufficient funds are available.

Capitalizing on its success in slashing CWTs, the Army extended the Velocity Management initiative in two ways: to processes other than order fulfillment and to performance dimensions other than time. The Velocity Group established additional PITs to apply the D-M-I method to the Army's repair, inventory management, and financial management processes. For each process, the goal of the PIT was to make the process perform faster, better, and cheaper.

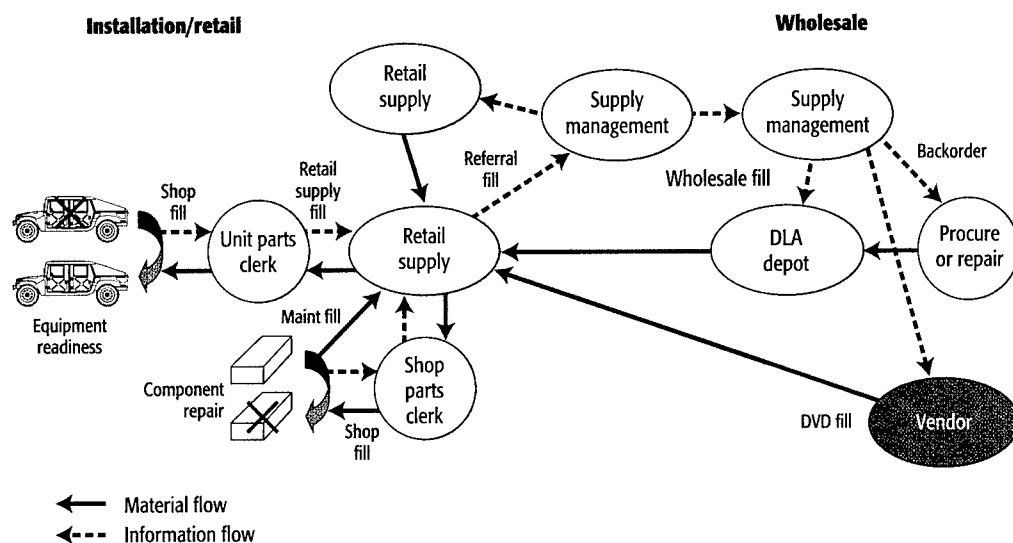
Optimizing the Performance of Inventories

In spare parts alone, the Army owns literally billions of dollars worth of inventory, and these stocks are stored at many locations on installations as well as in large supply depots. For each location, the Army's inventory management process determines what items should be stocked (breadth of inventory) and how much of each (depth). These two aspects of the location's stock position determine what level of investment will be required and what level of performance will be achieved. The Velocity Group wanted the PIT to increase both the effectiveness and efficiency of this process.

From the perspective of an equipment maintainer, a request for a spare part can be filled from various sources of supply.¹ Figure

1 Note that the meaning of the term "customer" is a function of where one is in the supply chain.

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● **Figure 15** Maintenance requests for spare parts are filled by a complex supply chain

15 (an elaboration of Figure 5) shows these various paths for filling customer requests. Beginning at the left side of the figure, seven paths are highlighted:

- When the customer's request is filled from his or her own local stocks (including the maintainer's own bench stock), this is referred to as a local or shop fill.
- When the customer's request is filled from its supporting Supply Support Activity (SSA), this is referred to as retail supply fill.
- When the customer's request is filled by a part that was just repaired by the local Army maintenance activities, this is referred to as a fill from maintenance.
- When one SSA fills the request of another SSA's customer, this is called a referral.
- When the request of the SSA's customer is available at the time the request is received and is released immediately by the wholesale inventory manager (usually automatically, via computer), this is called an immediate issue from wholesale.
- When a wholesale item manager forwards the request for a part to a commercial firm which ships the item directly to the customer, this is referred to as a fill via Direct Vendor Delivery (DVD).
- Backorders refer to requests that are not available for release at wholesale level (or anywhere else in the search pattern) at the time the request is received.

The performance of stocks located in SSAs, the warehouses on Army installations, are of particular concern because these are the closest to many of the mechanics who are responsible for bringing a faulty weapon system back quickly to full operational capability. Stocking a part very close by makes it possible to get a part quickly to the mechanic who needs it to repair a weapon system. Unfortunately, stocking a few of every spare part in close proximity to every mechanic who might need one is unaffordable for the Army. Moreover, many Army "warehouses" are housed in small, readily transportable, shed-like containers because they must be able to deploy with the units that they support. This requirement imposes size and weight constraints that preclude keeping extremely bulky, long, or heavy items on hand.

Following the D-M-I methodology, the Stockage Determination PIT began by visiting installations to define the inventory management process. Part of the process is automated, so it was also necessary for the PIT to review the stockage algorithms that were embedded in Army software.

Even before improvements to the process or to the stocks themselves were identified, the walkthroughs had an important side benefit. They quickly identified opportunities to improve warehouse storage and workflow. Working with installation SITs, the Stockage Determination PIT made a number of quick improvements. These included reducing the number of containers required to store a given amount of stocks, co-locating fast-moving items and putting them closest to the area where they were issued to customers, and using available technologies (such as handheld scanners) to reduce the workload associated with receipting items. As a result of these improvements, the local warehouses became more efficient.

The PIT also gained an improved understanding of the financial constraints on transitioning from an existing stock posture to another. This transition typically involves returning some items and purchasing others. However, the supply managers on an Army installation typically lack sufficient resources to purchase every item that they might want at a given time. One way to generate resources is to turn in unneeded items, but the managers often do not receive full credit for unneeded items. So moving from a current stock posture to a desired one must usually be accomplished in stages as resources become available.

To measure the inventory management process, the PIT proposed metrics that address the dimensions of time, quality, and cost. These metrics are useful not only for evaluating existing stocks but also for comparing alternative approaches to determin-

ing the proper size and configuration of stocks at all echelons so that they satisfy customer needs over time, both in garrison and in deployed operations. The same metrics are applicable at all echelons of the Army's inventories, although the discussion here focuses on installation warehouses.

Inventory management metrics fall into two sets: performance metrics and resource metrics. Both types are needed in order to balance the responsiveness of support to customers (time and quality dimensions of performance) with investments in inventory and the use of other constrained resources, such as transportation requirements (cost dimension of performance).

Among performance metrics (see box), CWT merits precedence because it focuses inventory managers on their customers' perspective and, implicitly, on equipment readiness. From the perspective of a mechanic who needs a spare part, the most important performance attribute of the supply chain is how long he or she waits for an order to be filled.

As the many paths on Figure 15 suggest, CWT is determined by many factors. Of those orders filled locally, some are filled by the retail supply point, some by neighboring warehouses, some by local commercial vendors, and some by local maintenance actions. For items that are stocked and available, CWT from these local supply points tends to be very fast, sometimes even the same day. Other items cannot be obtained from nearby sources and must be obtained from a distant supply depot or commercial vendor. CWT for these orders is necessarily longer and typically more variable. Finally, CWT for orders that must be backordered may be very long, even months.

When CWT is reported, it represents an aggregate of these processes. This is illustrated in Figure 16, which shows CWT for one month (June 2000) and for one set of customers (the maintainers of one division). Following the convention established in Figure 9 for displaying CWT, in this figure CWT performance in days is displayed at the 50th, 75th, and 95th percentiles, as well as

Performance Metrics for Inventory Management

- **Equipment readiness:** The percentage of weapon systems that are operational.
- **Customer wait time (CWT):** The amount of time that the shop's supply clerk (customer) waits for an order to be filled.
- **Fill rate:** The percentage of customer requests that are immediately filled from a given inventory point.
- **Accommodation rate:** The percentage of requisitions for items that are regularly stocked (that is, there is a location in the warehouse for that item), whether or not the requested item is available at the time of the request. Accommodation rate measures the effectiveness of inventory "breadth."
- **Satisfaction rate:** The percentage of accommodated requests for which there is stock available at the time of the request to issue to the customer. Satisfaction rate measures the effectiveness of inventory "depth."

at the mean. The bar on the far left shows the overall CWT for the month. The bars to the right indicate the CWT from each of the different sources shown in Figure 16 (wholesale backorders are only partially depicted because the bar heights are off the scale). The numbers below the bars on the x-axis are the percentage of orders filled by each source during that month.

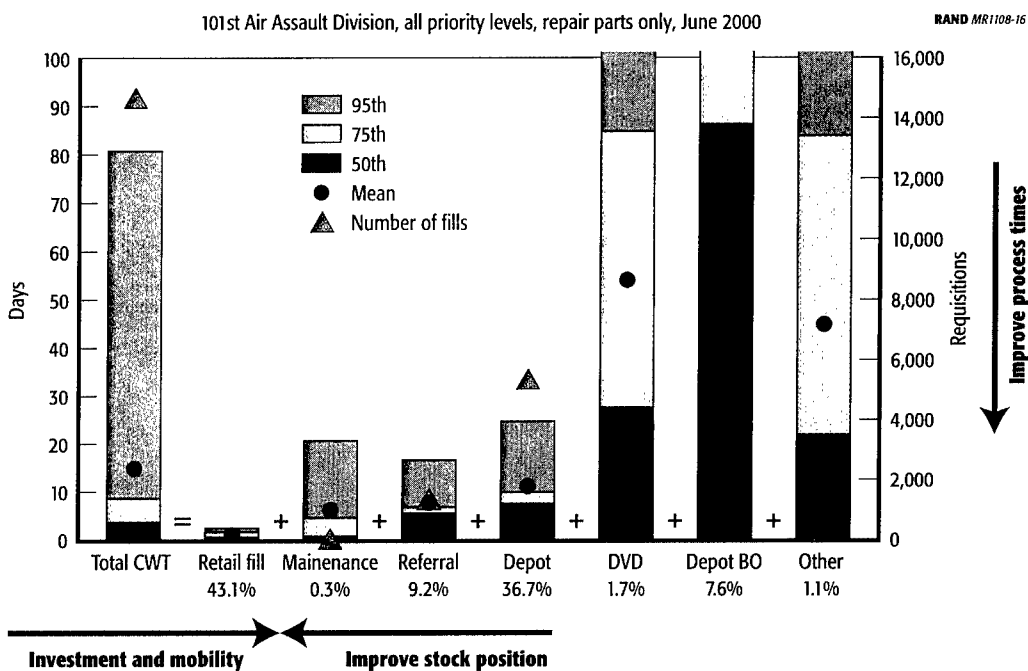
Generally, there are two strategies for reducing CWT, indicated by the arrows on Figure 16. As the rightmost arrow indicates, one strategy is to reduce process times for each process that affects it. For instance, the reduction of CWT for orders filled by the supply depots, described in Chapter 2, helped to reduce overall CWT. Similar efforts are improving the order fulfillment processes from other sources of supply.

The second strategy, indicated by the center arrow, is to improve stock position so that more items are available closer to the customer. By improving stock position, a higher proportion of orders can be filled at supply locations with relatively short CWT, and a correspondingly smaller proportion are filled from locations with relatively long CWT.

How well units can do in terms of performance metrics such as CWT is constrained by resource metrics (see box).

A key resource metric is the dollar value of the requirements objective (RO), the best indication of the total inventory investment. But additional metrics are required to reflect accurately the expenditures and investment in inventory, mobility, and workload.

● **Figure 16** CWT aggregates the performance of processes throughout the Army logistics system



For instance, it is difficult to devise one metric that reflects the workload needed to manage and operate an inventory location. To a large extent, warehouse flows and the design of the issue, receipt, and storage areas drive workload. Even a small number of issues and receipts can tax a workforce if the processes and warehouse are not efficiently designed.

The improvement effort focused on reconfiguring the inventories held in the retail supply activities. In Figure 16, the beneficial effect on CWT of filling the customer's order from a retail supply point is immediately apparent by comparing the height of the component bars. The average CWT for retail supply fills is less than a day and a half, whereas CWT for nonbackordered requests filled from wholesale sources of supply is almost an order of magnitude longer.

In hopes of increasing fills from retail supply, the Stockage Determination PIT carefully reviewed the algorithms used by the Army to compute which items to stock (inventory breadth) and how much of each to stock (inventory depth). The PIT determined that these algorithms could be substantially improved because they did not account for several factors that would affect inventory performance for a given level of investment. These factors include the following:

Resource Metrics for Inventory Management

- **Inventory investment:** The most common metric of inventory investment is the dollar value of the requirements objective (RO). The RO for a stocked item is the maximum amount that the supply clerk should order up to for that site when replenishing inventory levels. It is the sum of a number of individually computed elements, such as safety stock, war reserve requirement, and stock to cover demand over the order cycle. (The computation is unit price times the requirements objective summed over each of the different items stocked.) Other useful metrics of inventory investment are the dollar value of the reorder point (ROP, the inventory level at which replenishment is initiated) and dollar value of inventory greater than the RO (inventory above the RO can occur when unanticipated customer returns occur).
- **Transition costs:** Periodically, inventory levels need to be adjusted to reflect changes in demand patterns or replenishment times. This is the stockage determination process. Transition costs involve up-front investments to increase inventory levels of existing lines or to add new lines. Transition costs also include turn-ins generated by reductions in the inventory levels of existing lines or elimination of existing lines.
- **Workload:** Workload refers to the level of activity required to fill customer orders and maintain inventory at the proper levels. Two workload indicators are the sum of the receipts from all sources and the number of customer issues.
- **Mobility:** For many Army units, deployment footprint and mobility on the battlefield are matters of great importance. One metric of inventory mobility is the number of "lines" or types of items, because these correspond to the number of storage locations required in the warehouse. Another metric is the number of cubic feet that is represented by the RO, calculated as the sum of the cubic feet of each item as if held at the RO quantity. Another metric is the number of trailers or containers used to store inventory.

- **Cost of an item:** Items vary greatly in cost, and one has to weigh carefully the tradeoffs involved in stocking very expensive items.
- **Mobility:** Some items are too long or bulky to be stored in the ninety-inch containers that are used to deploy most stocks.
- **Demand pattern:** Some items are needed on a regular basis, while demand for others is "lumpy."
- **Transition costs:** Sometimes an Army unit lacks sufficient funds to accept all recommended changes to its existing inventory. For this reason and others, inventory improvement is inherently a continuous process. (Factors affecting recommended inventory levels, such as demand patterns and replenishment time, also change over time.)

Supporting the PIT, RAND analysts developed improved algorithms that accounted better for these factors. These algorithms affected both the recommended breadth and depth of inventories, resulting in improved fill rates.

Improved Inventory Breadth

In considering whether to add or remove an item from the inventory, the new algorithms calculate the tradeoff between improved supply performance and inventory investment. The stocking of inexpensive items permits a performance gain to be achieved with little investment; therefore, the new algorithms significantly increase the breadth of items stocked. Much of the increase occurred in items that cost less than \$10. A substantial number of items that cost between \$10 and \$100 were also added.

The increased breadth improved the fill rate because mechanics obtained more of what they needed from the retail supply point. CWT improved because they obtained these items almost immediately. Moreover, because many of these low-cost items were small, the stocks remained mobile—their total weight and volume increased only marginally and in some cases declined. The resources that were needed to add breadth were obtained by removing from the storage locations those items that were no longer in demand and by decreasing the depth of stockage on items that had little recent demand. In addition, warehouses and containers were reconfigured to use space more efficiently. These actions freed up space for other items and also generated funds through the credit received for turn-ins.

Improved Inventory Depth

To assure that a stocked item will be available when a customer

● In considering whether to add or remove an item from the inventory, the new algorithms calculate the tradeoff between improved supply performance and inventory investment.

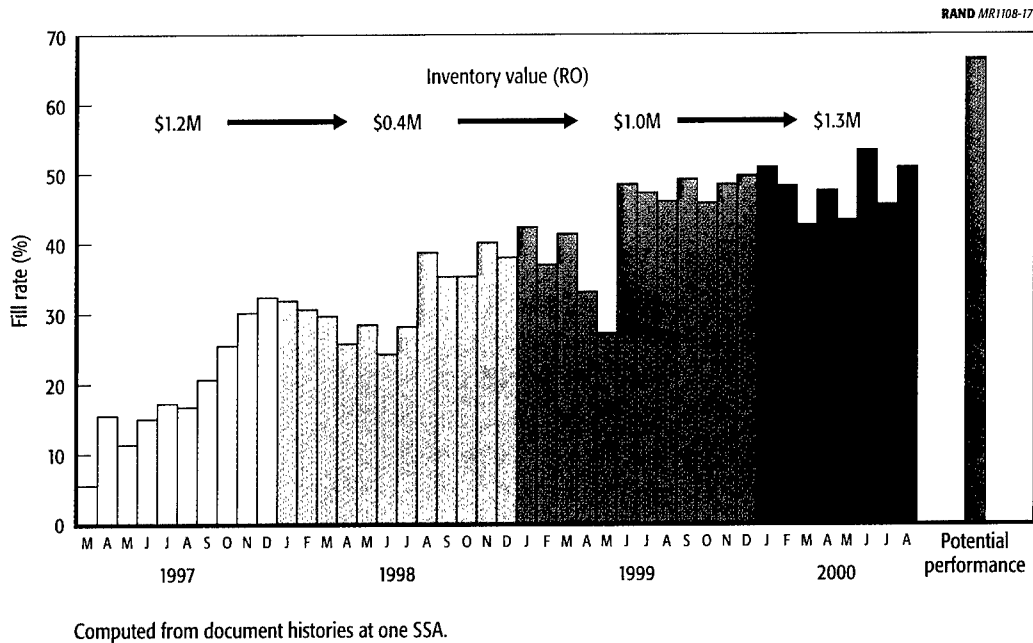
requests it, the item must be stocked at sufficient depth so that enough are on hand when the request occurs. However, too much depth represents a waste of resources that could be better used elsewhere. Under Velocity Management, the depth of inventory held at retail stock positions was improved in two respects.

First, the calculation of inventory depth was adjusted to reflect the improved CWT from wholesale sources of supply. Much quicker and more reliable CWT meant that less stock had to be held as a buffer to cover the time needed to resupply the inventory. All other things being equal, as CWT improved, inventory depth could be reduced without increasing the risk of a backorder.

Second, the logic for calculating inventory depth was adjusted to reflect the lumpiness of customer demands. Previously, the Army's logic reflected the simplifying assumption that demands are distributed uniformly over time. For example, an item that experiences 365 demands over a year would have a mean demand rate of one demand per day. The Army logic assumed that this mean reflected the actual demand pattern, and it set a depth sufficient to ensure that this demand rate could be satisfied by the stocks on hand. However, actual demands are very rarely so uniform: on a given day, more than one customer may request the item, and any given request may be for more than one of the item. As a result, when the depth of the stock has been established only to meet a mean demand rate, some requests will probably not be satisfied, and backorders will occur.

Under Velocity Management, a new depth algorithm was devised that recommended sufficient depth to cover the actual demand patterns, item by item. For items whose demand patterns have been extremely lumpy, with some periods of very high demands, the depth that is required to satisfy all demands without a backorder may be great. If the item is an expensive one, the required depth may be prohibitively expensive. Recognizing that cost is a factor in determining depth, the new algorithm permits stockage performance goals in terms of CWT, similar to service levels, to be set higher or lower depending on the cost of the item to be stocked. For low-cost items, the performance goal for CWT can be one or two days, implying that enough depth will be carried to make backorders rare even if demand is very lumpy. For higher-cost items, the performance goal in terms of CWT would probably be longer to recognize budgetary constraints.

As with the effort to reduce the Army's CWTs, the efforts to improve inventory performance have resulted in immediate and dramatic improvements that are continuing. Figure 17 shows how the performance of one local supply warehouse has improved



● **Figure 17** Broader, shallower stocks yield better fill rates for about the same investment

steadily in terms of fill rate. Before the improvement effort, the inventory performed very poorly, filling only about 5 percent of its customers' requests. As the improvement effort progressed, this rate increased to about 50 percent.

The inventory values on the chart show that the performance improvement was achieved at about the same levels of investment. Before the implementation of new algorithms, this supply warehouse had approximately \$1.2 million in inventory. In the first phase of improvement, unneeded items were returned for credit. As a result, investment levels dropped sharply from \$1.2 million to just \$400,000. In the second phase, some of the credit was used to add lines that broadened the inventory and improved performance. During the third phase, the breadth of the inventory was further expanded as funds became available. The investment level rose to \$1.3 million. In short, the cost-effectiveness of the inventory improved significantly.

After this approach to improving inventory performance was demonstrated at one installation, it was quickly implemented at other sites. The Army has almost 150 supply warehouses serving customers who are on active duty. Over 80 percent of these sites have implemented at least one iteration of the new algorithm or are in the process of doing so at the time of this writing. Figure 18 shows the Army's progress in improving the inventory performance of the supply warehouses supporting the ten active divisions.



Each column represents the performance of a Supply Support Activity.

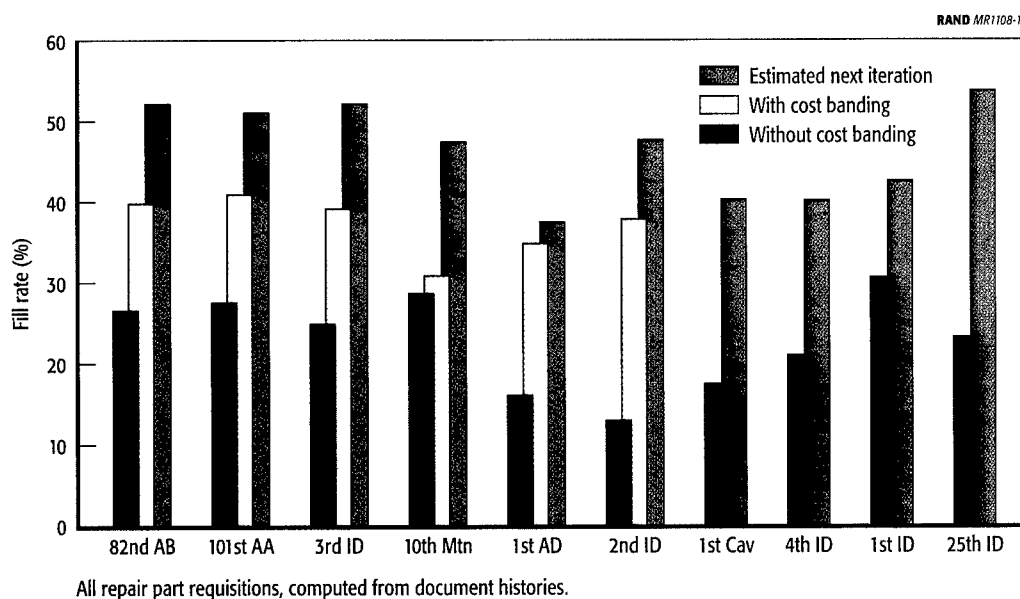
Reducing Repair Times

Both the reduced CWT for orders filled by wholesale supply and the improved fill rates at local stocks help Army mechanics receive the parts they need sooner. The Velocity Group was determined to translate the reduction in time awaiting parts into reduced delays in the repair of equipment, thereby contributing to improved equipment readiness.

Following the D-M-I methodology, the Repair PIT began to apply VM to the repair process by defining the repair cycle for selected weapon systems and component groups. Under VM, the Army stipulated a definition of "repair cycle" that is not limited to hands-on repair time in the shop; rather, it extends from the time an item is reported broken to the time it is repaired and made available for use. Thus, repair cycle time (RCT) includes time to recover a vehicle, time to retrograde materiel, time to diagnose faults, time awaiting parts or labor, and time for other activities besides just "wrench-turning." All these segments, since they contribute to the total time that a broken item is unavailable for use, were included in the scope of the PIT's efforts.

As part of the Define step, members of the Repair PIT and members of several VM SITs walked the repair process at a number of major Army installations, including Fort Irwin, site of

● **Figure 18** As the Army reconfigures local inventories, fill rates are rising





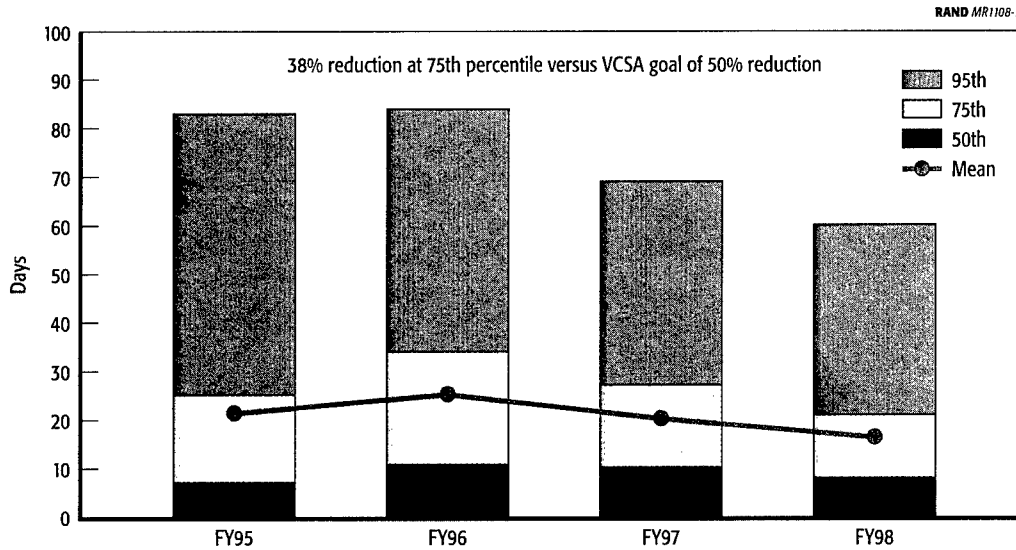
the National Training Center. These walkthroughs enabled them to develop a common, detailed understanding of the repair process as practiced. Based on these walkthroughs, the Repair PIT developed a generic flow diagram or "map" to represent the existing repair process.

The PIT discovered that it was difficult for the Army to measure the repair cycle under this broadened definition. Army data systems were not designed to measure the full repair cycle, from "broken to fixed," for most components. RAND analysts demonstrated that RCT measurement could be accomplished by combining elements from a number of data systems. Their research showed that the Army's RCT, like CWT, was much too long and variable, both for components and end items. In 1996, the Army's Vice Chief of Staff, then General Griffith, set a goal of reducing RCT by 50 percent.

The Repair PIT members identified many opportunities for improvement on their walkthroughs of the repair process, some of which could be implemented almost immediately. The walkthroughs gave rise to many ideas about how to eliminate non-value-adding activities and improve the remaining value-adding activities. For instance, the Army quickly instituted relatively simple procedural changes that reduced the administrative workload on maintenance personnel at all levels, allowing them to spend more time performing repairs and less time checking on each other and creating a paper trail. The flow of the repair process improved because repetitive inspections were eliminated. The inspections that remained were linked to specific technical data requirements. Similarly, elimination of unnecessary cleaning procedures has saved maintenance manpower, reduced the wasted time spent waiting for these activities to be scheduled and completed, and reduced potential environmental contamination.

These VM efforts to improve the repair process have had significant benefits. Figure 19 shows four years of repair cycle time performance, the baseline period (i.e., FY95) and the three subsequent years. Although further improvement is possible, the average RCT at this major Army installation is down 38 percent at the 75th percentile. The improvements have also been remarkable at the 95th percentile, indicating that the process is much more reliable in its performance.

As the time span of the figure suggests, the installation has been able to sustain these improvements in the repair process. Moreover, they were achieved without added expense. The faster availability of repair parts from supply channels certainly helped, but the units did not receive increases in manning or other



SOURCE: WOLF data for 510 part numbers tracked by RCT PIT.

● **Figure 19** RCT for Fort Campbell ground units shows significant improvement

resources. Neither did they increase the amount of overtime worked. To the contrary, local Army leadership reports a noticeable reduction in the repair workload and in the backlog at all levels.

Improving the Quality of Financial Information

The logisticians responsible for maintaining the Army's equipment and managing its spare parts inventories conduct financial transactions daily and are responsible for managing budgets. To do so requires them to know the prices they must pay for parts they order and the credits they will receive (if any) for parts that they return, both broken and serviceable. They depend on the Army's financial management process to provide these data, as well as other financial information (such as budgets), in a timely, accurate, and reliable manner.

When a financial management process is not fast and accurate, or creates errors and delays, it places obstacles in the path of efficiency and effectiveness. A poorly performing financial management process hampers efforts to improve the speed and accuracy of key logistics processes. Recognizing the need to improve the performance of the Army's logistics financial management process, the Velocity Group formed a Financial Management PIT to apply the VM methodology.

When defining logistics processes other than financial management, such as the supply process, VM PITs had to trace



flows of both materiel and information. By contrast, the financial management process deals strictly with information, both as an input and an output. (Even when the process moves funds, it moves them in the form of information, not as physical cash.) Examples of inputs to the financial management process are the amount of budget available, the price of an item to be purchased, and the amount of credit expected for the return of an item. The outputs of the financial management process are usually a series of reports that show where money was spent, how much of the budget is left, and the price of outstanding requisitions.

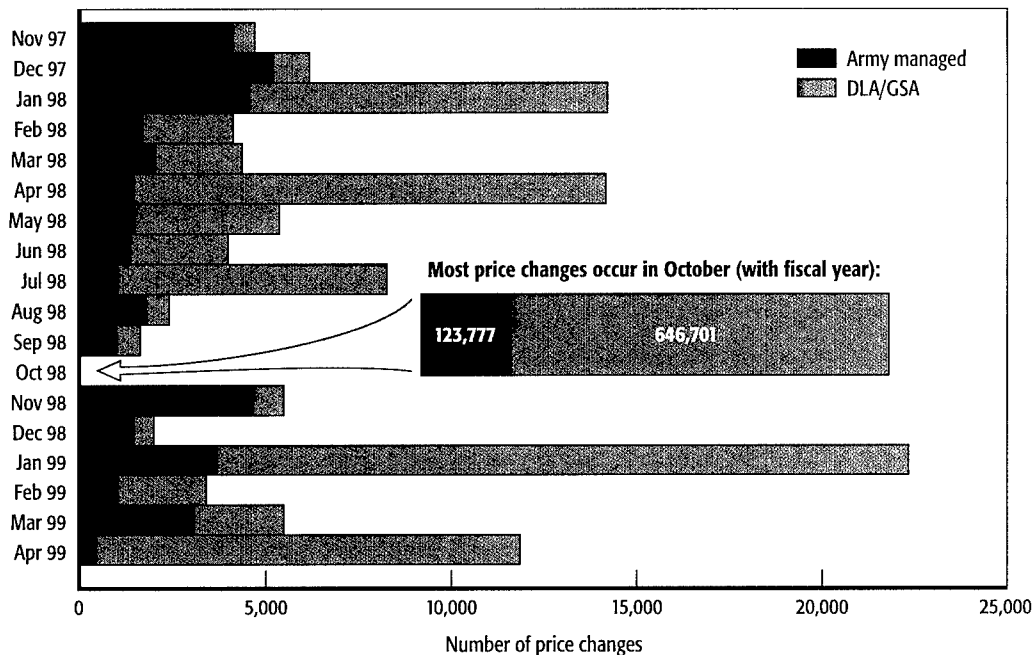
Measurement of the "goodness" of logistics financial management focuses on the timeliness and quality of financial information. Price and credit information is of particular concern because so many logistics decisions depend on the knowledge of how much money a unit has to spend at a given time. When price and credit information is poor or not current, it is very difficult for logisticians to keep track of how much they have spent, and how much they have remaining in their budgets. At any given time, they may have many outstanding requisitions and returns, but the price they will pay or the credit they will receive is uncertain, because prices may change between the time of the requisition and the receipt, and because credits depend on the installation's net asset position.²

Walkthroughs of the financial management process and analyses of its performance both indicated that the Army needed to focus on improving the quality of critical financial information. For instance, the PIT observed that the poor quality of price and credit information created a heavy workload. Many clerks manually adjust the financial records of their units so that they correspond to the latest computer printouts. For instance, they laboriously review their records for differences between an item's price when it was ordered and when it was received—a problem seldom encountered in the commercial world, because commercial customers typically pay the price in effect when the item is ordered, whereas Army customers pay the price in effect when the item is received and receipted.

Many Army financial management personnel and policy-makers believed that this policy was acceptable because prices rarely changed in the Army's catalogs, except between fiscal years, i.e., in October. However, RAND analyses of price data showed this belief to be unfounded, both for items managed by the Army itself and for those managed by the DLA and by the General

2 The Army is combining its wholesale and retail working capital funds into a Single Stock Fund. Under Single Stock Fund, the Army determines the credit given for a returned item based on the asset position for that item in the Army as a whole. In addition, the Army adjusts credits less frequently, thus reducing credit variability.

RAND MR1108-20



SOURCE: Federal Logistics Data File.

● **Figure 20** Thousands of prices change monthly throughout the year

Services Administration (GSA). In fact, thousands of price changes occurred monthly throughout the year (Figure 20).³

The problems associated with poor and untimely price and credit information become particularly acute at the end of each fiscal year, when customers try to spend all their remaining funds at the same time that any outstanding requisitions are being revalued at the new fiscal year's prices. As a result, financial checks may be imposed at many levels, including the unit, division, corps, and installation, to try to ensure that funds are available before requisitions are released. These added checks appeared to add no value: there were no indications that any requests affecting weapon systems were rejected. Rather, these checks wasted expensive management time. Worse, they hurt customer service. Financial checks create delays in order fulfillment time and thus potentially lengthen repair cycle time and increase the amount of local inventory that must be held to satisfy demands during the ordering cycle.

The FM PIT sought many improvements to the financial management process: reducing the uncertainty in prices and credits, locking in the price or credit when the transaction is initiated

3 The Army has attempted to reduce price and credit changes by locking at the values used to create the President's Budget. However, these values may include errors that would affect logistics customers and supplies throughout the fiscal year, so some price and credit changes must occur to correct such errors.



instead of when it is closed, reducing the time it takes to provide financial information (e.g., catalogs and budget updates), and improving access to information. The PIT judged that such improvements would greatly reduce the amount of time that units spend on financial reconciliation and tracking budgets, freeing up time for them to spend on their primary missions. Improving financial information may require investments in some key areas, such as changing automated systems to permit price and credit stabilization, providing telephone and network connections to motor pools, or funding trained administrators to ensure that data files are loaded correctly.

Many of the changes needed to improve the financial management process cannot be made by individual installations. They require policy changes at the Headquarters Department of the Army or the Office of the Secretary of Defense. In some cases, they may require cooperation with the Army from other Department of Defense and government agencies, such as the Defense Logistics Agency, the General Services Administration, and the Defense Finance and Accounting Service.

For instance, one important Armywide improvement would be to stabilize prices by locking in the price of an item at the time of requisition. This would eliminate a major driver of the reconciliation workload. Another example would be to produce a single catalog that all Army systems access for price information.⁴ This would eliminate another possible source of poor price information.

A continued commitment from Army leadership is required to secure cooperation across functional stovepipes both within and outside the Army and to secure the funding needed to implement change.⁵

● The problems associated with poor and untimely price and credit information become particularly acute at the end of each fiscal year.

4 Most Army motor pools receive their catalogs monthly on a CD-ROM. For their catalog to be correct, they must receive the CD-ROM and install it at the same time that higher-level supply systems receive their updated catalogs electronically.

5 For detailed discussions, see Brauner et al. (2000a and 2000b).

4 Linking Process Improvement to Increased Equipment Readiness

Suppose you heard that your favorite restaurant had improved its business processes. It had streamlined its ordering process, improved delivery of needed food products, and sped up food handling, meal preparation, table service, and payment processing. As a consequence of these improvements, the owners of the restaurant presumably increased its profitability. Yet you might still reasonably wonder whether you would notice a difference as a customer. Would the food be better?

The customers of the Army's logistics system are in a similar position. What they want is for their vehicles and other equipment to be in good working order and available for their missions. It is all well and good that Velocity Management is achieving its goals of making Army logistics processes measurably faster, better, and cheaper. But have these improvements actually helped equipment readiness? It could be, for example, that spare parts are now supplied to maintainers more quickly, but other aspects of the process have not changed to capitalize on this improvement. Or perhaps the need to reorder parts because an initial diagnosis of the problem was faulty or incomplete has diluted the benefits of improved inventory management and distribution.

As Figure 14 showed, when the Army implemented the Velocity Management initiative, it anticipated that equipment readiness would ultimately benefit. Yet it was unable to measure the connection between equipment readiness and the performance of individual logistics processes. For instance, when a weapon system was unavailable or "down" for a period of time, the Army lacked the capability to determine how much of the downtime was due to delays in getting spare parts, how much to the performance of local inventories, how much to the diagnosis of the broken vehicle, and so forth. Conversely, the Army could not estimate the degree to which improvements in any of these areas might benefit equipment readiness. Such knowledge would help the Army to better target and prioritize its process improvement efforts.

What the Army needed was a tool analogous in intent to the activity-based cost systems that some corporations use to assess the



contribution of every process to overall operational results. With activity-based costing, managers in these organizations know where the problems and opportunities are, which process improvements are paying off, and where additional leverage is possible—all in terms of their bottom line. The Army has a different bottom line—equipment readiness rather than profit—but it needs a similar capability. It needs a tool that links measurement of the performance of logistics processes to equipment readiness.

The Equipment Downtime Analyzer

An important outgrowth of the Velocity Management initiative was the development of such a tool, called the Equipment Downtime Analyzer (EDA). (See Peltz et al., forthcoming.) The EDA is helping the Army more effectively employ VM's Define-Measure-Improve methodology by tightening the linkage between measurement activities and improvement activities.

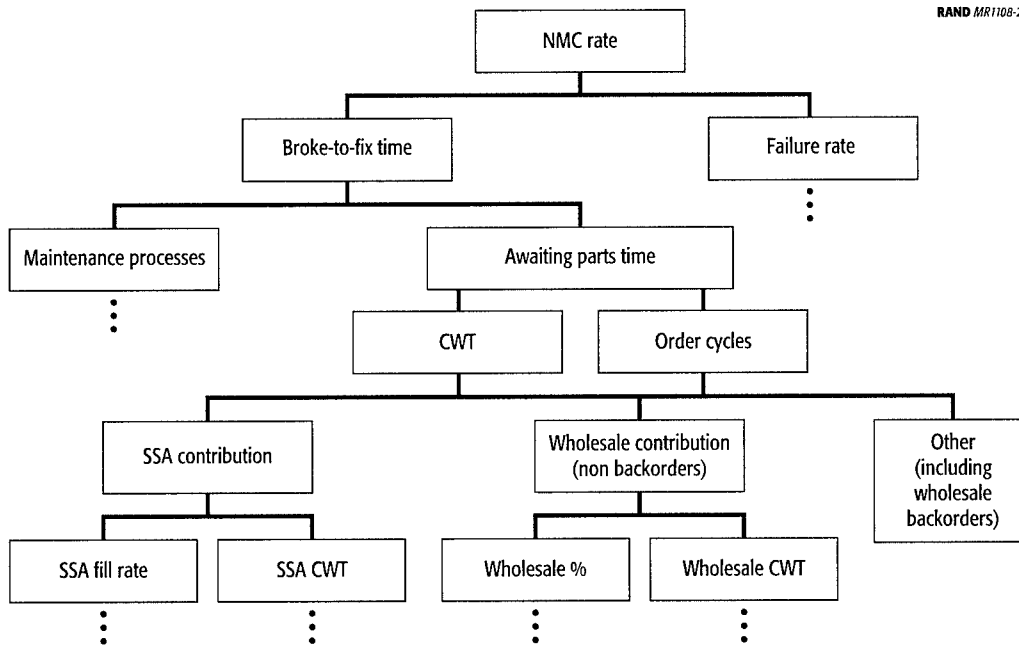
The EDA is a relational database that saves, integrates, and analyzes data already collected by existing standard Army management information systems (STAMIS). It requires no new or special data collection. It captures a history, by day, of the supply and maintenance activities executed to correct every reported failure that causes a major piece of equipment to be unavailable ("not mission capable"). In this way, it determines how much each process and organization contributes to equipment downtime. From the daily histories, the EDA produces metrics that fully describe equipment failure rates and the "broke-to-fix" process. Thus, the EDA provides a system view that can detect whether improvements in basic processes, such as the order fulfillment process, "bubble up" to affect equipment readiness or whether reactions in other processes consume the improvement. And it can be used to highlight the places where improvements would make the most difference to equipment readiness.

Assessments of the EDA have shown that it can give Army logisticians insight into equipment readiness comparable to that which their private-sector peers have into operating profits. The EDA will help the Army answer questions such as these:¹

- How does improving CWT affect equipment readiness?
- How does the performance of local inventories affect equipment readiness?

¹ This list emphasizes the EDA's utility in guiding process improvement. It has a similar utility for improving equipment design. It can help to answer questions about the failure rates of equipment types, such as these: How reliable is current equipment? Which parts contribute disproportionately to lost equipment readiness? What is the readiness rate of the Army's equipment when it is at work in the field during training exercises? When it is sitting in the motor pool?

RAND MR1108-21



● **Figure 21** The EDA uses data from Army management information systems to create a hierarchy of linked metrics

- How long does it take logisticians to return a fighting force to a high state of readiness following operations?
- What process improvement or expenditure of resources would produce the biggest gain in equipment readiness?

Diagnosing the Reasons Why Equipment Is Not Ready

A key metric for gauging equipment readiness is the “not mission capable” (NMC) rate. The NMC rate is the percentage of time during which a weapon system is not available for anticipated missions: a NMC rate of 10 percent means that the equipment was not ready 10 percent of the time. To diagnose the reasons why a system is NMC, the EDA depends on a simple mathematical relationship:

$$\text{NMC rate} = \text{average repair time} \times \text{average failure rate}.$$

This calculation begins a further drilldown in two directions, to the reasons underlying the factors of repair time and failure rate, respectively. The EDA can do this because it integrates the various data into a hierarchy of linked metrics. The top few levels of this hierarchy are displayed in Figure 21.

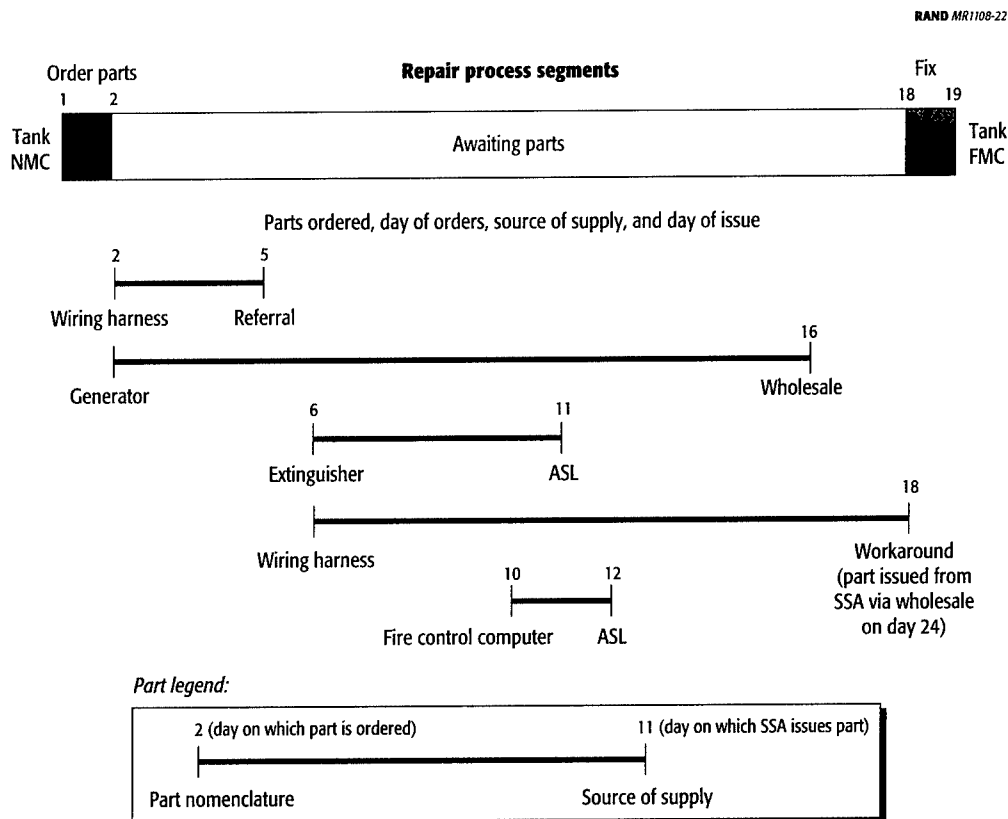
One way that the EDA sheds light on equipment readiness is by providing more information about the repair process, from the time a failure occurs until the equipment is repaired and again available for use. Figure 22 illustrates an actual history recorded by

the EDA for a down (NMC) tank. The figure shows the repair process segments for a tank that was down for 19 days. This period includes the three major segments indicated on the horizontal bar: time spent diagnosing the problem and ordering parts, time spent awaiting parts, and time spent applying the parts. After the initial diagnosis on day 1, clerks ordered parts based on this diagnosis on day 2, and the mechanics waited until day 18 for the parts to arrive. At that point, they fixed the tank in one day and returned it to fully mission capable (FMC) status.

One might think the time spent awaiting parts for a repair consisted simply of ordering a set of parts and then waiting for them to arrive. In the case depicted in Figure 22, and in many others, the EDA reveals the situation to be much more complex. In addition to the three major segments, the figure shows the day on which the clerks ordered each part, when the supporting SSA issued each part to maintenance, and the source of supply.

● **Figure 22** An EDA repair history for a "deadlined" (not mission capable) tank

- For example, the wiring harness was ordered on day 2, the SSA issued it on day 5, and it was supplied through referral from another supply point on the installation.



- However, a second wiring harness had to be ordered because the wrong one was sent the first time.
- Moreover, the extinguisher was ordered late because at first the maintenance personnel didn't realize that they needed it.
- Finally, this tank's fire control computer was "donated" to the repair of another tank, prompting the need to order one for this tank.
- Of further note regarding the second time the wiring harness was ordered, maintenance personnel decided to stop waiting for an issue from supply once twelve days had passed. Instead, they satisfied the need through alternative means (for example, removing the part from another down vehicle, as was done in this case with the fire control computer) on day 18, which allowed completion of the repair.

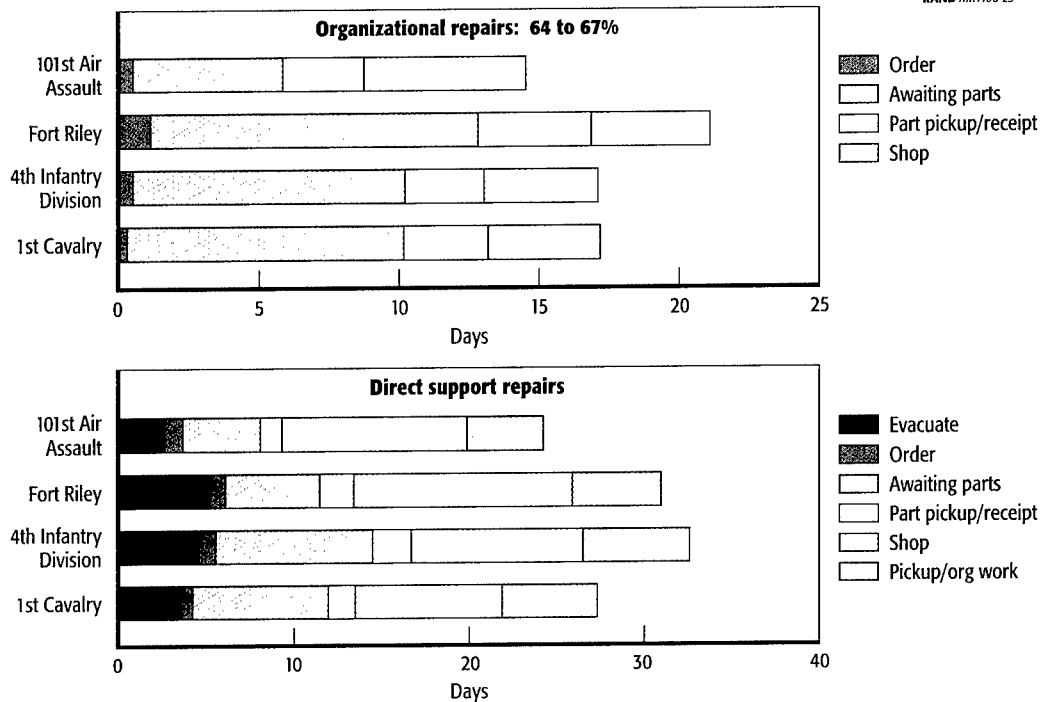
The EDA can measure the frequency of workarounds (e.g., removing a part from one vehicle to apply to another) or multiple ordering cycles (e.g., because of a changed diagnosis).

By combining these detailed histories, the EDA can produce both repair process and equipment reliability metrics at any level of aggregation, ranging from an individual tank through the entire Army fleet.

The EDA can also distinguish the performance of different maintenance units and of different levels of maintenance in the Army. For example, Figure 23 illustrates the performance of two levels of maintenance at four Army installations. The top panel compares the performance of the maintenance crews within the organizations that own the equipment. This level handles about two-thirds of the repairs on NMC equipment. The lower panel compares the performance of the maintainers in the maintenance unit in direct support of those organizations; some repairs must be evacuated to this level of maintenance.

The length of each section of the bar represents how much time that activity required relative to the whole process. A comparison of the bars reveals that no matter where the repair took place (at the organizational level or through direct or general support), time spent awaiting parts is an important contributor to total repair time. The importance of parts availability to equipment readiness is why the Army has put so much effort into improving the order fulfillment time from wholesale sources of supply and increasing the fill rate of local inventories, as described in the preceding two chapters.

RAND MR1108-23



● **Figure 23** Awaiting parts is a major contributor to total repair time

Putting the EDA to Work

In tests of the EDA, Army organizations have already identified several ways to exploit the more precise and complete insight that its data allow. It can be used to help evaluate and thus improve design reliability, to make recapitalization decisions, to identify operating shortfalls, and to enhance supply and maintenance policy analyses. The U.S. Army Materiel Command can take a fleet perspective to identify systemic part and weapon system issues and to identify units likely to benefit from technical assistance. The Army's Tank-Automotive and Armaments Command (TACOM) would like to incorporate the EDA into its Situational Awareness effort, which is designed to provide better visibility into customer needs in order to better target TACOM efforts to provide customer support. In other research sponsored by the Army, RAND Arroyo Center is using EDA information for analyses of the factors affecting equipment readiness. For example, the EDA has been especially useful in understanding equipment readiness in the high-pressure, deployed environment of the National Training Center at Fort Irwin, California.

In some of these applications, the EDA provides information not previously available that will improve the quality of decision-making. In other cases, it will help automate tasks that are now

executed manually. For example, some Division Materiel Management Centers manually compute average repair time using the daily deadline reports. This time-consuming process can be executed in seconds with the EDA.

The Army is taking steps to make this powerful information tool available for use throughout the Army. It is targeted for integration into the first release of the Army's new management information system for logistics, the Global Combat Support System-Army (GCSS-A).

The ultimate promise of the EDA is an enhanced capability to focus constrained resources where they will have the greatest effect on keeping equipment ready to fight, whether by improving equipment reliability or by reducing repair time. By enabling logisticians and those engaged in the acquisition and recapitalization processes to examine which improvements are most likely to achieve higher equipment readiness, the EDA should improve the Army's ability to sustain equipment readiness while reducing total support costs and enhancing mobility.

5 Sustaining the Velocity Management Initiative

In the early 1990s, before the development of Velocity Management, the Army logistics system suffered chronic performance problems that had resisted repeated efforts to remedy them. When poor performance becomes the accepted way of doing business in an organization, then the barriers to change are not only technical: they become deeply ingrained and cultural. For this reason, transforming the Army's logistics system required a shift in concepts and values.

The Velocity Management initiative provided the Army with a new way of thinking about and organizing logistics processes to be more efficient and effective. The difference between the traditional paradigm and the new paradigm under Velocity Management is summarized in Table 1. As indicated in the table, under the traditional paradigm, logistics was viewed as "piles of things." Logistics performance was measured by metrics such as days of supply (DOS), a measure that focused on mass. More massive piles were believed to be better than less massive ones in terms of providing effective support.

● **Table 1** Velocity management requires Army logisticians to shift to a new paradigm

Aspects of Army Logistics	Traditional Paradigm	New Paradigm
Definition of logistics	Piles of "things"	Set of processes delivering products and services
View of the logistics system	Provider view, by function: <ul style="list-style-type: none"> • Transportation • Ordnance • Quartermaster 	Customer view, by process: <ul style="list-style-type: none"> • Order fulfillment • Repair • Inventory management • Financial management
Metrics	Days of supply	Time, quality, cost
Reporting	Average performance	Median performance and variance
Management focus	Compliance Budget execution	Customer satisfaction Performance improvement

● System thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots.

—Peter Senge

In practice, Army logistics was not managed as a system. Rather, groups of logistics activities were managed independently. Logistics comprised several separate functional groups (e.g., transporters, maintainers, supply personnel), distinct echelons, and multiple sites. The Army undertook many initiatives to improve elements of the logistics system, but without a system view, even a locally successful initiative could have only an incremental impact on the total system's performance, and its overall impact might be unintendedly negative. Metrics were local, focused on average performance and driven by an emphasis on efficiency rather than customer satisfaction. Measurement was used to assure compliance and to aid budgeting and other planning, rather than to foster improvement.

Under Velocity Management, the new logistics paradigm encourages the Army to view logistics as a set of linked processes, rather than as individual functions or piles of things. More important, the focus shifts to the customer of the processes and how processes ultimately serve customer needs. Do the speed, quality, and cost of these processes help soldiers to accomplish their missions or impede them? Managers focus on communicating customer requirements throughout the system and ensuring that the processes to satisfy these requirements are continuously improved.

At the outset of the Velocity Management initiative, Army logisticians commonly asked, When will this initiative end? Initially, they did not conceive of it as a new paradigm for managing the logistics system. As a new way of doing business, Velocity Management has no planned end point. By comparison, consider that Motorola's famous Six Sigma program began in 1979 and isn't over yet. The Toyota Production System, forebear of today's lean systems and lean supply chains, began in the years following World War II, and it also is going strong.

The Army is using a number of mechanisms to ensure that the Velocity Management initiative is sustained beyond a single budget cycle or general officer's tenure. Some of these mechanisms are intellectual in nature, others are organizational, and others are tactical.

A Compelling Vision

One mechanism is the use of a vision that sums up a new way of doing business in the future. The substitution of "velocity for mass" has proved to be a clear and compelling vision. It is readily grasped by people at all levels of the logistics workforce, from entry-level high school graduates through technical experts and senior leaders.

The Army has incorporated the Velocity Management vision into the Army's Strategic Logistics Plan (ASLP), which describes the shift from "mass" to "velocity" as the first stage of a "Revolution in Military Logistics."

Assured Succession

Transformation of large systems and complex processes takes time—many years—despite dramatic and continuous improvements early in the implementation period. Quality experts such as Deming and Juran cite sustained leadership as a necessity for organizational change. In a commercial setting, a single person can drive the transformation of a company: a top-level manager has sufficient scope of authority and may retain the position of leadership almost indefinitely. For a number of reasons, sustained leadership is more difficult in the military, despite the perception of some that it operates with a rigid hierarchy and command structure. To the contrary, the commanders of military installations and organizations are accorded a strong degree of autonomy and authority. Moreover, officers change assignments about every two years as a matter of normal career development. As a result, in the military, long-term transformation must be managed by a coalition of leaders who share a common vision and values and by their like-minded successors.

In addition to convening leaders of sufficient scope and authority to make systemwide change, the Army's formation of the Velocity Group helped to solve the problem of how to sustain an initiative that by its nature must outlast the tenure of any given general officer, and even any cohort of general officers. The Velocity Group helps to foster an unbroken line of succession in leading the transformation. General officers enter the coalition while in one position, then often move to other positions in the coalition as the Army rotates them through assignments to increase their knowledge and experience.¹

● The D-M-I method has proved to be a simple, powerful tool that is readily understood and communicated.

Institutionalized Improvement

Another key to sustaining the Velocity Management initiative was the institutionalizing of an improvement method. The D-M-I method has proved to be a simple, powerful tool that is readily understood and communicated. It has been instrumental in build-

¹ The rotation of Army general officers to joint positions at the Defense Logistics Agency and the U.S. Transportation Command gave rise to the Strategic Distribution Management Initiative, which is applying the VM approach to improving the DoD distribution system.



ing consensus, achieving results, and sustaining momentum in the Velocity Management initiative.

Of particular importance is the Measure step, which includes activities that changed the Army's accustomed ways of understanding and communicating the performance of logistics processes. Measurement entails the development and implementation of appropriate metrics that span the full process and reflect key customer values. These metrics become the lingua franca by which all the stakeholders in a process communicate with one another about the goals and status of their improvement efforts.²

Speedy Reform

The Army has helped to sustain the Velocity Management initiative by maintaining a quick pace. Speed has proved important to the initiative for several reasons. One reason for making needed change quickly is simply to put an end to some of the delays, errors, and waste that are associated with the current way of doing business. A second is to prevent the organization from perpetuating two or more competing ways of doing business that are inconsistent and may evolve into de facto competing standards. A third is to keep the organization's change capabilities exercised, so that the improvement of process performance is understood as a continuous goal, not as a one-time transition to a new target state. And a fourth is to prepare the entire organization for the next wave of innovation.

Continuous Innovation

Another key to sustaining the Velocity Management initiative has been to extend it systematically to new processes and sites. These extensions continually renew interest in the initiative. Chapters 2 and 3 related how the Army expanded the Velocity Management initiative throughout the logistics processes associated with spare parts. Reform began with the order fulfillment process, then progressed to related processes such as the repair process, inventory management, and logistics financial management. Now the Army is extending the Velocity Management approach to improve logistics processes that support classes of supply other than spare parts.

● Another key to sustaining the Velocity Management initiative has been to extend it systematically to new processes and sites.

2 A beneficial byproduct of using data to support process improvement is that the data quality improves very quickly: those who are trying to use the data uncover previously unnoticed quality problems, and those who are responsible for inputting and maintaining the data are alerted to the importance of its accuracy, completeness, and timeliness.

For instance, the Army's traditional processes for distributing ammunition show some of the same characteristics as those for spare parts before the application of VM. The Army's training ammunition forecasting policies and order fulfillment procedures have seen little change since the end of the Cold War. Long lead-time forecasts, on the order of six months to a year into the future, are the norm, and local retail sites in CONUS (ammunition supply points or ASPs) are authorized to hold ninety days or more of anticipated training needs. The processes used to request, return, and manage training ammunition are often performed manually and are not necessarily electronically connected.

Although the initial focus is on training ammunition, the performance of these processes also has implications for wartime. Because today's Army is accustomed to dealing day-to-day with the training ammunition system's long lead times, large amounts of local buffer stocks, and oftentimes manual requisition processing, it is unlikely that either the requisitioning customers or the logistics supporting base will be able to switch smoothly to a leaner and fast-moving wartime ammunition requisition and order fulfillment system.³

Resources

It is difficult for any organization to sustain an initiative that requires large expenditures or budgetary commitments each year. The competition for dollars is too great, and the pressure to document a commensurate "return on investment" builds. One key to the Army's success in sustaining the Velocity Management initiative is that it has emphasized the achievement of performance improvements within the constraint of existing (sometimes declining) resources. For example, the initiative has relied on data from existing Army management information systems, integrating and analyzing these data in innovative ways, rather than implementing new systems.

Notwithstanding the need to avoid costs, organizations that seek change need to make some critical resources available, particularly those that provide the knowledge and information needed for change. People who are new to an initiative and eager to participate need to know what to do and how to go about doing it. In the case of Velocity Management, Site Improvement Teams can

● To start the turnaround thus requires a willingness to rethink and to re-examine the company's business theory. It requires stopping saying "we know" and instead saying "let's ask."

—Peter Drucker

3 RAND research in support of this extension is co-sponsored by the Army's Deputy Chief of Staff for Operations and Deputy Chief of Staff for Logistics.

draw on several sources of expertise. They can consult directly with Armywide Process Improvement Teams. They also contact the researchers at RAND who continue to provide analytic support to the initiative, and RAND can provide them with a wide range of technical reports documenting the Army's previous experience in implementing Velocity Management. The Velocity Management Web site maintained by the Army's Combined Arms Support Command provides SITs with other documentation and contact points. The Web site also contains the Army's performance data on Velocity Management metrics, which the SIT can use to understand and diagnose the performance of logistics processes at its own installation and to track the effects of its own improvement efforts.

6 Coda: Velocity Management and the Transformation of the Army

In 1996, in testimony before the Senate, General Dennis Reimer noted that "there cannot be a Revolution in Military Affairs unless there is a Revolution in Military Logistics." Late in 1999, when a new Army Chief of Staff, General Eric K. Shinseki, unveiled his vision for the U.S. Army, he echoed the point, noting that the Army needs to "revolutionize the manner in which we transport and sustain our people and materiel." In fact, Shinseki went further, promising "a comprehensive transformation of the Army."

One reason that Shinseki could announce such a bold plan was the success that the Army had achieved in implementing reforms of its logistics system under Velocity Management and related initiatives. By dramatically improving the performance of key logistics processes, the Army had quietly laid the institution-wide groundwork for supporting a transformation in how it deploys and fights (see Edwards and Eden, 1999).

For decades before the implementation of Velocity Management, the quality of military logistics fell progressively behind best commercial practices. The performance gap became a source of frustration, cost, and risk. It became common to refer to logistics as a "burden" to operations.

But in just the past few years, the Army has begun to cinch tight the major links in its supply chain for spare parts, which contributes directly to improved equipment readiness. Today a high-velocity, streamlined Army order fulfillment process delivers spare parts in half the time it took to deliver them just three years ago. The Army has ramped up its logistics performance to world-class standards. Now it takes less time to get a spare part from a supply depot than from a commercial vendor. And with higher velocity has come better quality and lower costs along the full length of the Army's supply chain.

Under the Velocity Management paradigm, the Army continues to transform its logistics system into a strategic asset that can support new concepts for deploying and fighting. And in doing so, the institution has unexpectedly demonstrated a remarkable capability for achieving quick, dramatic, and lasting change.

Velocity Management has gained currency among senior DoD officials, and several DoD elements outside the Army have sponsored RAND research to apply the concept to improve their logistics processes, including the Marine Corps, the Navy, the Defense Logistics Agency, and the United States Transportation Command.



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● Logistics has become even more important to the performance of an enterprise. It is the new basis for competition in business. It enables government to operate more efficiently and effectively [and] Internet-based services to work economically.

—James A. Champy,
"The Age of
Logistics," foreword
to Mark Y.D. Wang,
Accelerated Logistics



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VELOCITY MANAGEMENT

The Business Paradigm That Has Transformed U.S. Army Logistics



Velocity Management has brought a new way of doing business to U.S. Army logistics, with a renewed focus on the Army customer and a powerful approach for process improvement that cuts across three critical performance dimensions: time, quality, and cost. The goal is to reduce the need for massive logistics resources by increasing the speed and accuracy with which materials and information are delivered. Key logistics processes are defined, measured, and improved continuously, so that customers—Army units in garrison and deployed worldwide—get what they need, when they need it, and at minimal cost.

The results are telling: Army logistics processes that were massive in scale, unresponsive to change, unreliable in performance, and inefficient have undergone dramatic and sustained improvement. Today a high-velocity, streamlined supply process delivers repair parts in less than half the time it took to deliver them just three years earlier.

The authors reveal the story of Velocity Management's success: the motivations, methodology, and management structure behind the initiative; the process improvements that have led to quick and impressive results; and the steps taken to develop and institutionalize the capabilities needed to achieve and sustain future improvement.



MR-1108-A